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REPORT

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of

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The Infantry Board

No. 1894

MORTAR (HOWITZER, 4.2", RECOILLESS, FOR INFANTRY USE

FORT BENNING, GEORGIA

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Classification changed by
authority of CG, AGF
13 Nov 45
/s/ E. D. Porter, Col., Inf.
E. D. PORTER

472.8/124 (C) (17 Dec 44) GNRQT-11/45046 3d Ind.

HEADQUARTERS ARMY GROUND FORCES, Washington 25, D. C., 14 November 1945

TO: Commanding General, Army Service Forces. ATTENTION: Research and Development Division, Room 4E 633, The Pentagon

1. Herewith report of test of Mortar, 4.2", Recoilless, conducted by Army Ground Forces Board No. 3 (formerly the Infantry Board).

2. The recommendation of the Board, that the development of the subject weapon be intensively continued to eliminate the deficiencies set forth in paragraph 3 of the subject report, is approved.

3. It is considered desirable to correct all known deficiencies before the subject weapon should be authorized for issue to Infantry troops. Therefore, the recommendation of the Board for the authorization of the issue of the weapon to Infantry troops prior to the accomplishment of the modifications requested in paragraph 3 of the cited report, is not approved.

4. It is requested that development of the subject weapon continue on a high priority with a view to correcting those deficiencies found by the board, and after development warrants it, that two (2) each of the subject mortars be furnished Army Ground Forces Board No. 3, Fort Benning, Georgia, for further test.

FOR THE COMMANDING GENERAL:

W. A. Tracy
Capt., A. G. D.
Asst. Ground Adj. Gen.

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Orig, dup, trip, and
quad cps of Incl #4 w/d

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GNRIS (D) 472 (30 Sep 45) 1st Ind. TVM/ad
Mortar (Howitzer, 4.2", Recoilless, for Infantry Use
HEADQUARTERS THE INFANTRY SCHOOL, Fort Benning, Georgia, 3 November 1945

TO: Commanding General, Army Ground Forces, Washington 25, D.C.

The Commandant concurs in attached Infantry Board Report No. 1894 except as follows:

(1) Par. 3c(2), Page II gives the impression that no indirect laying sight is necessary. Recommend that Par. 3c (2), page II, read as follows: "The sight, M19 is unnecessarily elaborate and although heavy does not provide the sturdiness required of an indirect fire sight for a weapon of this type.

(2) Par. 4b, page 13, basis of issue should be nine per Cannon Company since it would replace the tanks one for one in difficult terrain.

FOR THE COMMANDANT:

1 Incl:
No change

TROY V. MOORE
Captain, AGD
Asst Adj Gen

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TO	REMARKS OR INSTRUCTIONS	SYMBOL, DATE AND INITIALS
t Comdt	(Infantry Board Report No. 1894, dated 30 Sep 45, "Mortar (Howitzer, 4.2", Recoilless, for Infantry Use") For review and comments.	INF. SCH GNRIS (D) 29 Oct 45 T.V.M.
ief eapons ection	For convenience of Comment. Return by 1 Nov 45	RECORDED GNRID(A) 29 Oct 45 RBB
A/C n Coord Tng	The Weapons Section concurs in the conclusions and recommendations of AGF Board Report No. 1894, "Mortar (Howitzer, 4.2", Recoilless, for Infantry Use") dated 30 Sep 45 with the following exceptions: a. Par. 3c(2), page 11 gives the impression that no indirect laying sight is necessary. Suggest that par. 3c(2) page 11 read as follows: "The sight, E19, is inadequately sturdy, and is unnecessarily elaborate and heavy as an indirect fire sight for a weapon of this type." (copied) b. Par. 4b, page 13 basis of issue should be nine per cannon company since it would replace the tanks one for one in difficult terrain. For Chief of Section:	GNRID (P) 1 Nov. 45 O.C. O.C.
Exec. Officer	AC concurs in attached IB Report No. 1894 except as follows: (1) Par. 3c(2), Page 11 gives the impression that no indirect laying sight is necessary. Recommend that Par. 3c (2), page 11, read as follows: "The sight, E19 is unnecessarily elaborate and although heavy does not provide the sturdiness required of an indirect fire sight for a weapon of this type. (2) Par. 4b, page 13, basis of issue should be nine per Cannon Company since it would replace the tanks one for one in difficult terrain.	GNRID (A) 2 Nov 45 GRSJr. GRSJr.

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IB-472

Office of
THE INFANTRY BOARD

Fort Benning, Georgia
30 September 1945

SUBJECT: Mortar (Howitzer) 4.2", Recoilless, for Infantry Use

THRU: The Commandant, The Infantry School
Fort Benning, Georgia

TO: The Commanding General, Army Ground Forces
Washington 25, D. C.

1. a. (1) Authority: Letter, Hq AGF, 17 Dec 1944, (72.8/124 O) (17 Dec 1944) GNRQT-10/8956.

(2) References.

(a) Appendices "A", "B", "C", and "D", Inclosed Record of Test "Sights and Other Accessories for Use with the Recoilless Mortar 4.2 Inch" which cover chronologically the adaptation, modification, and fabrication of various items of equipment used as accessories.

(b) TIB Report 1664, "Improved Sights for 81mm Mortar".

(c) TIB Report 1612, "Infantry Plotting Board, M10".

(d) TIB Report 1902, "Panoramic Mirror Adapter for Sight M4".

b. Purpose: (1) (First Phase Expedited.):

(a) To determine the suitability of the 4.2" Recoilless Chemical Mortar (Howitzer) for Infantry use, with particular emphasis on tactical employment.

(b) To determine what, if any, modifications of weapon, mount or sighting equipment are necessary or desirable to adapt the weapon to Infantry use.

(c) To determine a suitable basis of issue, if any, of this weapon to Infantry units.

(d) Suitability for man-pack transportation.

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(Note: The Field Artillery Board was directed to conduct that part of the test relating specifically to accuracy, functioning of the ammunition, functioning of the material, animal transport, etc. The Airborne Center was to conduct drop-tests and general suitability for use in airborne units.) (Appendix "B")

(2) Supplemental Phase. (Experimental)

(a) To test various types of mounts, in an effort to obtain greater stability, flexibility and accuracy in comparison with the machine gun Tripod, Cal. .30, M1917A1.

(b) To determine whether a simpler, lighter and more rugged type of sight is desirable and feasible, both for direct and indirect laying.

(c) To determine whether the subject weapon lends itself to inclusion in an integrated fire-direction system with other infantry supporting weapons and with supporting artillery weapons, in connection with the use of plotting-board M10.

(d) To determine whether a more satisfactory method of igniting the driver-rocket of the ammunition for subject weapon, can be devised.

(e) To develop a suitable method of firing the subject weapon against moving targets.

(Supplementary Appendix "A", "B", "C" & "D")

c. Plan of Tests. (1) The First Phase of the test was abbreviated and expedited, in order to obtain data for presentation to "a meeting of representatives from Army Ground Forces, Service boards and various other agencies convened at The Infantry School, Fort Benning, Georgia, on 3 January 1945," and the findings, conclusions and recommendations, presented informally, are shown in the minutes of that conference. (Appendix "D", and Tabs "T-1" to "T-21", inclusive.)

(2) The Supplemental Phase was a continuation of the First Phase, and covered experimental tests in an effort to find specific means of overcoming the defects revealed during the First Phase, and to answer specific questions unsolved by the First Phase as to detailed distribution and employment of the weapon in conjunction with other infantry weapons. (Tabs "S-T1 - S-T12, inclusive, and "S-APA" to "S-APD", inclusive.)

2. Discussion.

a. Description of Material. (1) The 4.2" Recoilless Chemical Mortar (Howitzer) represents an adaptation of the recoilless principle to the standard 4.2" Chemical Mortar, through modification of the breech and of the propelling charge, and substitution of a light, low-angle mount for the heavy base-plate and biped. It consists of:

The tube of the 4.2" Chemical Mortar, fitted with sight bracket and mount adapter, with the breech-cap thread modified to receive the re-action chamber. Weight, complete: 65 lbs.

The re-action chamber, which is screwed on the breech end of the tube, and which permits the proper degree of expansion of the propellant gases and their escape towards the rear through specially designed venturi openings in such manner that reaction from the jet exactly balances the recoil and torque reaction from the propulsion of the shell through the rifled bore. It also contains the fixed firing pin. Weight, 59.25 lbs.

The mount, consisting of the standard Cal. .30 Machine-Gun Tripod Mount, M1917A1. Weight, complete, 50 lbs.

(2) The ammunition is the standard Shell for the 4.2" Chemical Mortar, modified by the substitution of a special propelling charge for the basic ignition cartridge, by altering the fuze nose to receive the driver rocket, which is a small rocket affixed to the nose of the shell for driving the round back through the bore against the firing-pin when the weapon is fired at elevations which preclude reliance on gravity for ignition of the propelling-charge. The driver rocket is screwed into the nose of the shell before loading, and is functioned by manually pulling out a pin passing transversely through the rocket body, thereby releasing the rocket firing pin, igniting the rocket and firing the piece. The weight of one round, complete, in its carton is 31 lbs. Average weight per round packed for shipment is 41.5 lbs.

(3) Mounts and Adapters:

(a) The Cal. .30 Machine-gun Tripod M1917A1 provides the same facilities for controlling the subject weapon in elevation and direction as for the Cal. .30 machine-gun, except the sights but including the azimuth dial, the free or clamped pintle, the free or clamped elevation arc and micrometer (fine) adjustments in mils for both elevation and deflection.

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(b) Adapter for 4.2 Inch Recoilless Mortar and Caliber .50 Machine-Gun Mounts.

This item (Figure 2, Part b, Record of Test, "Sights and other Accessories for Use with Recoilless Mortar, 4.2 Inch".) consists of two brackets supported by welding to a section of iron pipe. The lower ends of both brackets fit and assemble to the mounting bracket of any type of caliber .50 machine-gun mount, and the upper ends assemble to any of the recoilless weapons which can be assembled to a caliber .30 machine-gun tripod.

(c) Mounts, Machine-Gun, .50 Cal. AA.

1. M63 AA Mount, Modified, Type T12. This mount is a standard AA Mount modified for Infantry use of Cal. .50 machine guns by the addition of elevating and traversing hand wheels and a traversing dial. Recoilless weapons which fit the Cal. .30 machine-gun mount can be assembled to the Type 12 mount by use of the adapter (par. 2a (3) (b).

2. M63 Mount Modified Type 13. This mount is similar to the type 12 mount except that it has more rugged modification parts and more easily read dials. The pin which ties the cradle to the elevating segment was sheared in two before the tests started and was replaced by local Ordnance personnel by a heavier pin attached to the cradle by a flange instead of being secured by a taper pin to provide the assembly with greater torsional strength. The modification parts were poorly assembled and both the elevating and traversing mechanisms loosened frequently during tests.

(d) Lanyard Firing Devices.

Although four firing device were fabricated, only two were considered suitable for test. The Type 3 device consisted of a single linkage which extends when locked beyond dead center and, in addition to engaging the rocket pin, prevents the round from sliding into the tube when the piece is elevated above the critical angle of repose for the round. Rocket pin engages a single piece claw which starts pin removal in a line approximately in prolongation of the pin, but completes withdrawal in a line at an increasing angle with the pin.

Firing device Number 4 consists of a double linkage which, when the lanyard is pulled, totally extracts the rocket pin in a line approximately in prolongation of the center line of the pin. The pin engages in an adjustable claw which bites into the pin to provide positive gripping during removal of the pin. The device prevents round from sliding into the tube when latter is elevated above maximum angle of repose for the round.

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(e) Adapter for M4 Sight and 4.2 Inch Recoilless Mortar.

This device consists of male and female dovetail blocks mounted at a 45° angle to provide for flat trajectory fire. When the tube and the elevating bubble of the sight are level sight reading is 45°. Hence, settings of tube elevation from minus 5° to plus 45° are provided. An auxiliary table showing range in terms of values shown on the sight range dial is used in firing the mortar with the M4 Sight mounted on the bracket by means of the adapter.

(f) Panoramic Mirror Adapter for Sight M4.

This device is similar to the "Panoramic Mirror Adapter" (TIB Report No. 1664, "Improved Sights for 81mm Mortar") developed by the Infantry Board for use with Infantry type mortars and provides for azimuth control by the firer without changes in position of his line of sight relative to the tube and utilizes but one aiming stake instead of the three normally used with the M4 Sight for fire control. It consists of a small mirror mounted rotatably in front of the collimator on a rotatable horizontal azimuth dial from which azimuth of line of fire can be read direct, after initial location of aiming stakes. The device differs primarily from the original made by The Infantry Board and the pilot model fabricated by the Ordnance Department only in so far as mounting to the M4 Sight is concerned. In the original models, the mirror assembly was mounted on the collimator and gave a vertical or true image of the aiming stake only when the latter was level. In this model, the mirror adapter is mounted on the collimator base, which when the sight is level, holds the mirror in a vertical plane and makes it independant of the position of the collimator with respect to elevation. Tests of the device are covered in detail in TIB Report No. 1612, "Infantry Plotting Board T-10" and TIB Report No. 1902, "Panoramic Mirror Adapter for Sight M4".

(g) Bar (Iron) Sight for Sight M4.

This device is an adapter clamped over the collimator assembly of the M4 Sight comprising an open (rear) sight and a stud (front) sight with zeroing slots for paralleling the line of sight with the bore.

(h) Elevation Quadrant T13, with Telescope Adapter M9 and Elbow Telescope M-62.

In this item the M62 elbow telescope is mounted on a special elevation quadrant with an elevation scale graduated in 100-mil increments from minus 200 to plus 1600. A micrometer elevating knob used with the scale provides for one-mil elevation increments. Deflection features

are identical with those of the Elbow Telescope M62. Both elevation and cross-levelling bubbles are provided. Further details and results of tests with the 81mm mortar are covered in TIB Report No. 1664, "Improved Sights for 81mm Mortar".

(For Factual Background of various items see Exhibit "1".)

b. Details of Tests.

(1) The 4.2" Recoilless Mortar (Howitzer) is readily transportable on the battlefield, with a resulting mobility somewhat less than that of the present standard weapons of the Infantry Heavy Weapons Company, by any of the following methods.

(a) Man-carry, packboard, by a minimum squad of approximately six (6) men not including extra ammunition bearers.

(b) Hand-cart carry, on two (2) Handcarts M3A4, with minimum crew of approximately six (6) men, not including extra ammunition bearers.

(c) Trailed load, identical with (b) but with weapon mounted in firing position on Handcart M3A4, and both carts towed for longer moves by the Truck, 1/4-Ton, 4x4.

(d) Identical with either (a), (b) or (c), above, but with equipment and personnel carried on two (2) Trucks, 1/4-Ton, 4x4, each towing the 1/4-ton trailer. (Tabs T2 and T3)

(2) The practicable rate of fire obtainable with the present 4.2" Recoilless Mortar (Howitzer) varies from approximately three (3) rounds per minute for high-angle (gravity ignition) fire to approximately six (6) rounds per minute for low-angle (howitzer type) fire using driver-rocket for ignition. (Tab T4)

(3) The accuracy of the 4.2" Recoilless Mortar (Howitzer) firing from the Cal. .30 Machine-gun Tripod Mount M1917A1, is entirely adequate, considering the effective radius of the shell for supporting fire at ranges up to approximately 2000 yards, and is fairly adequate at ranges up to 3400 yards. It is inadequate at ranges beyond 3400 yards. (Tab T5)

(4) The maximum usable range of the subject 4.2" Recoilless Mortar without special arrangement for clearance of the breech-blast and for protection of gunners is approximately 3300 yards (elevation 500 mils). (Tab T5)

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(5) High angle fire (above ~~1600~~ mils elevation) is not feasible with the subject weapon without a special, high mount or other means of providing clearance for the breech-blast, of such nature as to be impracticable in the field. (Tab T5)

(6) The adequacy of the presently available method of loading and firing the subject weapon varies with the elevation as follows:

(a) Elevation, zero to 150 mils (Range approximately 1360 yards): Rocket ignition only. No difficulty.

(b) Elevation 150 mils to 250 mils (1360 yds to 2100 yards). Rocket ignition necessary but special arrangement or effort necessary to hold round in place at the muzzle until complete withdrawal of the pin. Results Slow rate of fire and some danger.

(c) Above 250 mils. Drop ignition only; Results satisfactory. (Tab T5)

(7) The driving-rocket body of the projectile for the subject weapon separates from the shell when the round is fired and becomes a separate projectile with trajectory different from, and much shorter than that of the shell, creating a considerable hazard to supported troops in the open. (Tab T4)

(8) The shell of the subject weapon is effective for direct fire against pill-boxes and earth-covered log bunkers. (Tab T6)

(9) The fuze of the ammunition for the subject weapon has a tendency to malfunction due to improper fitting of the driving-rocket adapter to the fuze body, and consequent collapse of the 3mm shoulder upon impact against a solid surface. This condition can be remedied by care in manufacture and assembly. (Tab T7)

(10) The material effect of the shell fired by the subject weapon is greater than that of any other weapon presently available in the Infantry or in the combat team. (Tab T8)

(11) The 4.2" Recoilless Mortar (Howitzer) is capable of effective fire by direct laying as well as by indirect laying methods applicable to other artillery and infantry supporting weapons. (Tab T9)

(12) Neither the sight, mount nor method of firing of the subject weapon is suitable for successful fire against moving targets. (Tab T10)

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(12) [illegible] the subject weapon from the standpoint of disclosing the location of the weapon to the enemy, are no greater than those from conventional guns and [illegible] by defilade because their principal action is downwards and to the rear, as compared to the [illegible] howitzers. (Tab T13)

(14) The cooling characteristics of the subject weapon are adequate for all purposes except relatively prolonged rapid fire. (Tab T12)

(15) The functioning of the subject weapon and ammunition is adequately reliable with the following exceptions:

(a) The Machine-gun Mount, M1917A1 is lacking in the rigidity, stability and ease of manipulation needed for full effectiveness of the weapon.

(b) The driver rocket of the ammunition is difficult to operate and uncertain in action due to crudeness of the firing pin.

(c) The driver-rocket is too frail to withstand transportation and handling when in place on the shell. (Tab T15)

(16) The sight, E19, furnished for the subject weapon is of [illegible] and stability to withstand the [illegible] when the weapon is fired, and is not well suited to direct laying.

(17) The spare parts, tools and accessories, other than the sight, authorized for issue with the subject weapon are adequate in number and type, except that a machine-gun clinometer for use in indirect laying in case of loss or breakage of the regular sight is not included. (Tab T16)

(18) The subject weapon is well adapted to battery fire by the same basic methods as, and in direct conjunction with, mortars and other Infantry supporting weapons. (Tab T17)

(19) The subject weapon is adequately sturdy and durable. (Tab T18)

(20) The ammunition for the subject weapon lacks adequate waterproofing of the propellant charge. (Tab T21)

(21) The restricting plate and powder support plate of the subject weapon require replacement after [illegible] rounds. (Tab T18)

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(22) The Cal. .50 Machine-gun Mount, M__, M__, modified to provide [illegible] hand-wheel controls, (Experimental models T12 and T13) has insufficient stability and sturdiness for use as a mount for the 4.2" Recoilless Mortar (howitzer). (Tabs S-T2 and S-T3)

(23) A lanyard-operated combination firing pin-puller and shell-holder device, mounted at the muzzle of the subject weapon, enabling the weapon to be fired by the gunner who lays it, is both feasible and desirable. ("Supplement" Record of Test, Figures 3 to 8, incl. Tabs S-T4, S-T5, S-T6, S-T7, & S-T8.)

(24) The Mortar Sight M4, with the Panoramic Mirror Adapter, would be an adequate sight for the subject mortar, if modified as follows:

(a) Provided with a forty-five degree adapter permitting the line of aim to be set parallel with the axis of the bore.

(b) Modified elevation-scale to read in mils from zero to 800 mils.

(c) Provided with a bar-sight or cross-hair reticle type collimator securely mounted on the present collimator base and fixed to it in elevation. (Supplement, Figures 9, 10 & 11. Tabs S-T9, S-T10.)

(25) The subject weapon is well suited to inclusion in an integrated fire direction system for infantry supporting weapons, based on Plotting Board M10, using any of the following sights and methods for laying the piece:

(a) The Sight M19, consisting of Elbow Telescope M62, Elevation Quadrant T13 and Telescope Adapter M9.

(b) Mortar Sight M4 with Panoramic Mirror Adapter and forty-five degree elevation adapter.

(c) Machine gun clinometer and Traversing Dial on Machine Gun Mount, Cal. .30, M1917A1. (Tab S-T11)

(26) The modified driver-rocket, fitted with the solid, round [illegible] for use as an [illegible] (Tab S-T12)

c. Comments on Tests. (1) Analysis of the above results of test indicates that the 4.2" Recoilless Mortar is by far the most powerful [illegible]

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holding the shell in place in the muzzle and pulling the pin by means of a lanyard manipulated by the gunner, appears wholly feasible, and should be developed.

(d) The principal components are a little heavier than desirable for man-carry, being approximately equal in weight to the present standard portable 81mm mortar. It would seem that experiments looking to some reduction of these basic weights might bear good fruit. Suggested for such experimentation are:

Lighter construction and lighter metals in the re-action chamber.

Lighter construction in the tube, possibly through resort to tube-extensions similar to those now used for the 81mm Universal Mortar.

Interchangeability of the tube with that of the 4.2" Chemical Mortar, by utilizing the same type and size of threads for the mortar base-cap and the re-action chamber.

3. Conclusions:

a. That the 4.2" Recoilless Mortar, considered as an Infantry howitzer, has limited but definite application as an infantry supporting weapon, both on the battalion and regimental level, against the present type

b. That issue of this weapon to Infantry units would definitely increase the independent and overall combat effectiveness of those units.

c. That the subject weapon is, in its present form, in a relatively crude and undeveloped state, in the following particulars:

(1) Mount (M.G. Tripod Mount, M1917A1) has insufficient rigidity and stability to support the weapon and to resist displacement of the lay when the weight of the shell is moved from the muzzle to the breech in the act of firing.

(2) The sight, E19, is inadequately sturdy, and is unnecessarily elaborate and heavy for a weapon of this type.

(3) A simple, direct fire sight, graduated for ranges up to at least 2000 yards, with deflection graduations for lead on moving targets is needed for this weapon.

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(4) An adequate means of controlling the weapon in direction with a free pintle by the gunner simultaneously with adjustments in elevation and operation of the firing device (trigger or lanyard) is needed for firing on moving targets, similar in principle to that in use on standard antitank guns.

(5) The present method of holding the shell in place and firing the weapon by an action [illegible] of the muzzle, is inadequate, and should be changed to one which permits the release of the shell and the firing of the weapon to be simultaneously by the gunner and lay the piece without interruption of the act of laying.

(6) The present driver rocket is unsatisfactory in the following respects:

(a) It is erratic and unreliable in functioning.

(b) It is frail and vulnerable to damage in handling or transport.

(c) It parts from the shell in flight and becomes an independent projectile which is hazardous to friendly troops.

(7) The maximum usable range is not commensurate with some of the situations in which a weapon of this type would probably be employed in the Infantry regiment.

(8) The individual components of the weapon when broken down for transport, are excessively [illegible] prohibitively heavy for man-pack carry under mountain conditions and for long distances, and should be lightened as much as practicable.

2. That when and if the defects enumerated above are remedied, the 4.2" Recoilless Mortar will be suitable and effective supporting weapon for use in the Infantry regiment and battalion to supplement present weapons of the Heavy Weapons Company and the Cannon Company.

4. Recommendations. The Board recommends:

a. That the 4.2" Recoilless Mortar be intensively developed by elimination of as many of the defects described in par. 3, above, as practicable with a view to its use as a howitzer for inclusion in the Infantry Heavy Weapons Company and the Cannon Company to supplement other weapons of those units.

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Sincerely yours,

Ingomar M. Smith
Colonel, Infantry
President.

1 Incl
Exhibit "A".

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Factual Background

1. The following listed items were developed by The Infantry Board and manufactured locally for use in tests of the 4.2" Recoilless Mortar:

a. Lanyard Firing Devices.

b. Adapter for mounting 4.2" Recoilless Mortar on caliber .50 machine-gun mounts (device also will adapt 75mm recoilless rifles to Cal. .50 machine-gun mounts).

c. Adapter for mounting M4 Sight on the 4.2" Recoilless Mortar for flat trajectory fire.

d. Bar Sight for the Sight M4 to adapt it for use as a direct fire sight with the 4.2" Recoilless Mortar.

2. The Modified Mounts, Machine Gun, Cal. .50, AA, Types 12 and 13 were furnished by The Infantry Board for tests to determine their suitability as mounts for ground type machine guns.

3. The panoramic Mirror Adapter was designed by The Infantry Board as an accessory to the M4 Sight to adapt it for use in indirect fire of Infantry mortar in conjunction with the M1C Infantry Plotting Board.

4. The elevation quadrant M3 used with the Mount M9 and Elbow Telescope M=62 was developed by the Ordnance Department to fulfill a requirement of Army Ground Forces published in the CCITS 2d Recovery List for an improved 81mm mortar sight.

EXHIBIT 1

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RECORD of TEST

ON

4.2 INCH RECOILLESS HOWITZER (4.2 INCH RECOILLESS CHEMICAL MORTAR)

TEST SECTION
THE INFANTRY BOARD

FORT BENNING, GEORGIA

TO: THE DIRECTOR, THE INFANTRY BOARD.
HEREWITH DETAILED RECORD OF TESTS
RELATING TO THE ABOVE PROJECT.

WILLIAM C. RUTHERFORD,
Lt. Colonel, Infantry.
CHIEF, TEST SECTION

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8 Copies.

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TEST SECTION
THE INFANTRY BOARD
FORT BENNING, GEORGIA

2 APRIL 1945

SUBJECT: RECORD OF TEST OF 4.2 INCH RECOILLESS HOWITZER (4.2 INCH RECOILLESS CHEMICAL MORTAR)

TO: THE PRESIDENT, THE INFANTRY BOARD, FORT BENNING, GEORGIA.

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S-E-C-R-E-T

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"C"	Memorandum for the Commandant, The Infantry School, 16 October 1944, subject, "Recoilless Guns".....	74
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1. Authority and References.

a. Authority:

(1) Memorandum, The Infantry Board, 12 December 1944, IB-472. (Appendix A)

(2) Letter, The Infantry Board, 22 December 1944, IB-472, with copies of correspondence. (Appendix B).

b. References:

(1) Memorandum for The Commandant, The Infantry School, 16 October 1944, subject, "Recoilless Guns". (Appendix C)

(2) Memorandum, Mr. G. C. Bowen to Dr. R. E. Gibson, subject, "Blast Tests on the 4.2 RCM".

(3) Pamphlet entitled, "The 4.2 inch Recoilless Chemical Mortar, E34R1, developed at Allegany Ballistics Laboratories in cooperation with The Chemical Warfare Service", dated 20 November 1944.

(4) War Department Training Bulletin TBCW 24, "4.2 inch Recoilless Chemical Mortar, E34R1."

(5) Stenographic notes on conference convened at The Infantry School on 3 January 1945, pursuant to AGF directive (See Appendix B). (Appendix D)

2. Introductory Information.

a. The subject 4.2 inch Recoilless Chemical Mortar was designed to provide a light portable weapon capable of being animal or man transported, and having ballistic characteristics permitting its use for flat trajectory fire employing, as nearly as possible, the standard Shell, HE, 4.2 inch Chemical Mortar, M3.

b. At this point it is well to state that the characteristics of the subject weapon remove it from the "mortar" class and place it in the "Howitzer" class. To prevent confusing the subject weapon with the standard 4.2 inch Chemical Mortar, the subject weapon will hereinafter be designated the "4.2 inch Recoilless Howitzer".

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c. In order to meet the requirements as stated in par. 2a above, the recoilless principle of interior ballistics was applied to the standard 4.2 inch Chemical Mortar. In applying this principle, a portion of the propellant gas is permitted to escape through the breech. This imparts a forward force to the weapon. When this forward force balances the normal rearward force (induced in overcoming the inertia of the shell) the weapon is recoilless and has neither forward nor rearward movement when the shell is fired.

d. The 4.2 inch Recoilless Howitzer consists, basically, of a tube, similar in dimensions to the standard 4.2 chemical mortar tube, fitted with a reaction chamber (or breech, designed for the proper control of gas emission to the rear) and mounted on a machine gun Tripod Mount, M1917A1. A telescopic sight, providing for either direct or indirect fire is mounted on the tube. (See Figure 1)

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4.2 inch Recoilless Howitzer

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Figure 1

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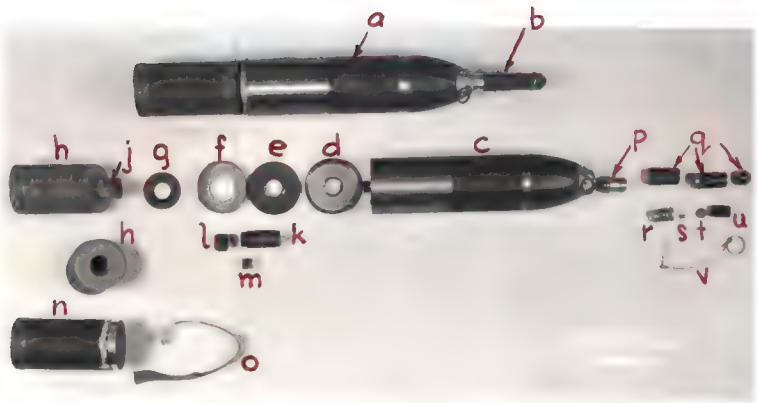

4.2 inch Shell, HE, E74

a - Shell and driver (b) complete
c - Shell
d - Rotating plate
e - Rotating plate expander
f - Powder carton end
g - Washer
h - Propellant powder
j - Igniter tube
k - Primer tube
l - Primer nut
m - Primer
n - Powder carton
o - Sealing tape
p - Driver adapter
q - Driver body (disassembled)
r - Firing pin and spring
s - Detonator
t - Igniter disc
u - Driver propellant powder
v - Firing safety pin and lanyard.

Figure 2

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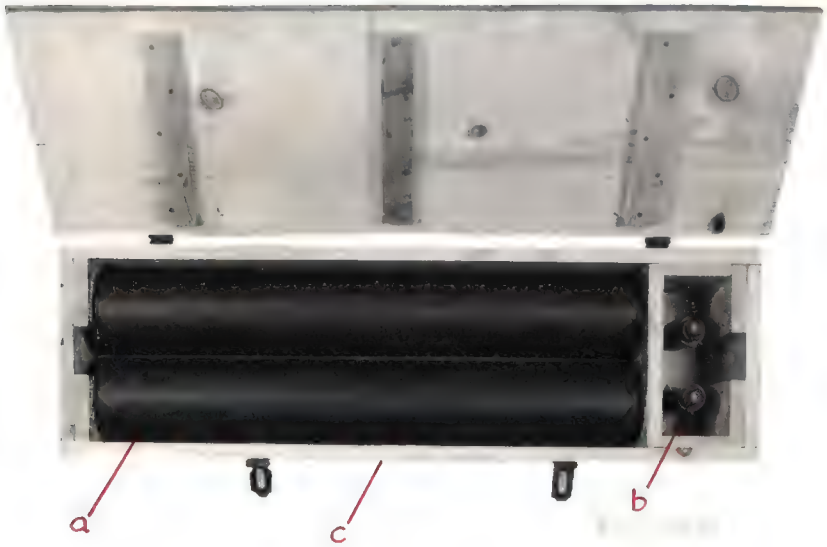

4.2 inch Shell, HE, E74

a - Two rounds in cartons

b - Drivers

c - Wooden shipping case

Figure 3

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3. Purpose of Tests.

To determine the suitability of the subject weapon with regard to the following:

a. Physical characteristics.

b. Mobility when carried by vehicle, hand, packboard and cart.

c. Crew size necessary for operation and transportation.

d. A suitable gun drill.

e. The time necessary to put the weapon into action and take it out of action.

f. The feasibility of vehicular mounting.

g. Rate of fire at low angle (with driver) and at high angle (without driver).

h. Accuracy on vertical targets.

i. Dispersion on the ground.

j. Effect on concrete or earth-log bunkers.

k. Cratering and/or fragmentation effect of the projectile.

l. The feasibility of using the subject weapon for direct and indirect fire.

m. The feasibility of firing at moving targets.

n. The dust, smoke and flash produced.

o. The effect of firing hot rounds and cold rounds.

p. Heating of the mortar and ease of handling while hot.

q. Feasibility of using standard 4.2 chemical mortar ammunition.

r. Feasibility of converting the 4.2" RCM to a standard 4.2 chemical mortar by use of the standard mortar base cap, base plate, etc.

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s. Durability.

t. Functioning of mortar and ammunition.

u. Suitability of sights.

v. Suitability of accessories.

w. Feasibility of using the subject weapon in battery fire, in view of previous studies on this subject.

x. Desirable modifications.

y. Other pertinent data.

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4. Details of Tests and Results.

Test No. 1

a. Purpose: To determine the physical characteristics of the 4.2 inch Recoilless Howitzer and its ammunition.

b. Method: By examination, weighing, measuring and comparison with the 105mm Infantry howitzer and its ammunition.

c. Results:

(1) The Howitzer. The 4.2 inch Recoilless Howitzer consists of a barrel and reaction chamber mounted on a triped mount and equipped with a telescope sight. The barrel is made from a standard 4.2 inch Chemical Mortar tube by changing the threads at the breech. The reaction chamber takes the place of a base cap and controls the gas emission to the rear. It also contains the firing pin, powder support plate and restricting plug for the control of the gas emission. The assembled barrel and reaction chamber are mounted on a heavy machine gun Tripod Mount, M1917A1. The barrel is fitted with a sight bracket to accommodate the Sight, E19. The sight bracket has a cross leveling adjustment to compensate for any lack of accuracy in the initial cross leveling of the weapon. The Sight, E19, is fitted with the M62 Elbow Telescope and Mount, M9, having 6400 mils traverse, and an elevation scale graduated from 0 to 1600 mils. The sight is equipped with longitudinal and cross levels for indirect laying. (Figure 1)

(a) Complete material for one 4.2 inch Recoilless Howitzer unit consists of the following:

Howitzer, complete, composed of:	
Tube and pintle bracket	65.00 lbs.
Reaction chamber	59.25 lbs.
Sight bracket	6.25 lbs.
Tripod mount (w/o cradle)	30.00 lbs.
Cradle	20.00 lbs.
Sight, E19, w/Inst. light in case	12.50 lbs.
Aiming post (2)	9.50 lbs.
Aiming post light (2)	2.50 lbs.
Cleaning staff	2.00 lbs.

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Tools, spare parts and accessories:	23.25 lbs.
1 Tool, combination	
1 Wrench, spanner	
2 pair gloves, asbestos	
1 Bracket, pintle	
1 each firing pin, powder support plate and restricting plug on protector plate	
1 Cap, thread protector, tube	
1 Cap, thread protector, reaction chamber	
Cart, M3A4, with mounting brackets	122.00 lbs.
5 Packboards with attachments	32.50 lbs.
(One packboard includes cradle cover at 1 lb.)	

(2) Ammunition. (a) The ammunition for the 4.2 inch Recoilless Howitzer is built around the standard 4.2 Chemical Mortar HE shell. The propellant has been increased and redesigned for the recoilless propulsion and the fuze has been modified to permit the attaching of a driver rocket. Physical characteristics follow: (Figures 2 and 3)

Length of shell w/o driver	27.0	in.
Length of shell with driver	31.0	in.
Weight of shell and propellant	28.4	lbs.
Weight of shell only	24.9	lbs.
Weight of driver	.75	lbs.
Weight of explosive charge	8.5	lbs.
Type of explosive charge	TNT	
Weight of shell in carton	31.0	lbs.
Weight of shipping box containing 2 rounds in carton and 2 drivers	83.0	lbs.
Weight of propellant	3.5	lbs.

The propellant is covered with a foil covered and painted cardboard carton for flame and water-proofing.

(b) The driver rocket is not attached to the shell for shipment. It is attached to the shell at the gun position and is part of the preparation of the shell for firing. Until attached to the shell the driver rocket is unarmed. Attaching it to the shell compresses the firing pin spring and the rocket will fire upon pulling the safety pin.

(c) Two types of fuzes are used; T45 delay fuze on HE shells and T48 S.Q. fuze on WP shells.

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(3) Following is a comparison of the general data for the 4.2 inch Recoilless Howitzer and the 105mm Howitzer, M3.

Data	4.2" Rec. How.	105mm How. M3
Weight on triped mount in firing position	180.0 lbs.	2495.0 lbs.
Weight on Cart, M3A4, in firing position, w/5 rounds (includes Howitzer, mount and sight)	507.0 lbs.	----------
Height, overall	28.0 in.	44.0 in.
Length, overall	53.7 in.	155.0 in.
Height, on Cart, M3A4	42.0 in.	----------
Length, on Cart, M3A4	78.0 in.	----------
Weight, 1 round HE complete	28.4 lbs.	40.5 lbs.
Weight, 1 round HE, shell only	24.9 lbs.	32.9 lbs.
Weight, HE charge per round	8.5 lbs.	4.8 lbs.
Muzzle Velocity	715.0 f/s	1020.0 f/s
Maximum Range	3735.0 yards	8295.0 yards

It is interesting to note from the above that, in the case of the 4.2 inch Recoilless Howitzer, 180 lbs. of weapon delivers a projectile containing 8.5 lbs. of HE, while in the case of the 105mm Howitzer, 2495 lbs. of weapon delivers 4.8 lbs. of HE.

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Test No. 2

a. Purpose: To determine the most equitable loadings of the materiel of the 4.2 inch Recoilless Howitzer unit for manpack, handcart, and motor transport.

b. Method: By study and trial.

c. Results: (1) Three basic types of transport have been provided for the Recoilless Howitzer, namely, manpack (packboard), handcart, and motor transport. Loadings for all three types are shown below.

(a) Packboard. Five standard packboards are furnished in the Howitzer unit. The most equitable loading of these packboards results in the following component loads: (Figures 4 and 5)

Load No.	Component		Weight (lbs)
1	Packboard complete		6.25
	Cradle cover		1.00
	Tripod and cradle assembled		50.00
		Total	57.25
2	Packboard complete		6.25
	Tube, sight bracket and pintle bracket		71.25
		Total	77.50
3	Packboard complete		6.25
	Reaction chamber		59.25
		Total	65.50
4	Packboard complete		6.25
	Sight		12.50
	Aiming posts and lights (2 each)		12.00
	Tools and spare parts		23.25
	Cleaning staff		2.00
		Total	56.00
5 etc.	Packboard complete		6.25
	Ammunition, 2 rds in cartons		62.00
		Total	68.25

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Previous tests of packboard transport show that the above loads, while suitable for very short distances on easily traversable terrain are generally excessive. For transport over extended distances it will be necessary to rotate the loads or divide the weight of each load between two or more men by means of carrying poles.

(b) Handcart, M3A4. One handcart has been provided in the Howitzer Materiel unit (Par. 1, above). However, a study of the loading has indicated the need for two handcarts in order to provide a reasonable amount of ammunition with the howitzer. Loadings for these handcarts follow: (Figures 6 and 7)

Cart No. 1

Components		Weight (lbs)
Assembled Howitzer and mount in mounting brackets		180.00
Sight		12.50
Aiming posts and lights		12.00
Tools and spare parts		23.50
Cleaning staff		2.00
Ammunition, 5 rounds in cartons		155.00
	Total	385.00

Cart No. 2

Components		
5 Packboards (Additional packboards for ammunition @ 6.25 lbs. each)		32.25 *
Ammunition, 10 rounds in carton		310.00
	Total	342.25

*One packboard includes the cradle cover at 1 lb.

As noted in the above tabulation for Cart No. 2, additional packboards may be added for transporting ammunition.

(c) 1/4-ton Trailer. Consideration of the Howitzer squad as a highly mobile unit sets up a requirement for two 1/4-ton trucks for its transportation. Attaching 1/4-ton trailers behind these vehicles permits the following loadings:

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Trailer No. 1

Components	Weight (lbs)
Handcart, M3A4	122.00
Component load for Cart No. 1 (par. 4b)	385.00
Ammunition, 5 rounds in cartons	155.00
Total	662.00

Trailer No. 2

Components	Weight (lbs)
Handcart, M3A4	122.00
Component load for Cart No. 2 (par. 4b)	342.25
Ammunition, 5 rounds in cartons	155.00
Total	619.25

(2) It will be noted that in the above compilation the packboards have been included in the handcart loads, and both packboards and handcarts have been included in the trailer loads. This provision will permit the crew to resort to the type of transport that is suitable to the terrain and will allow them to take full advantage of their most rapid means of transport until prevented by terrain limitations.

(3) As stated above, the packboard loads are generally excessive for transport over extended distances on the basis of one man per packboard load. However, the loads represent the most equitable distribution of weight within the limits imposed by the mechanical breakdown of the material.

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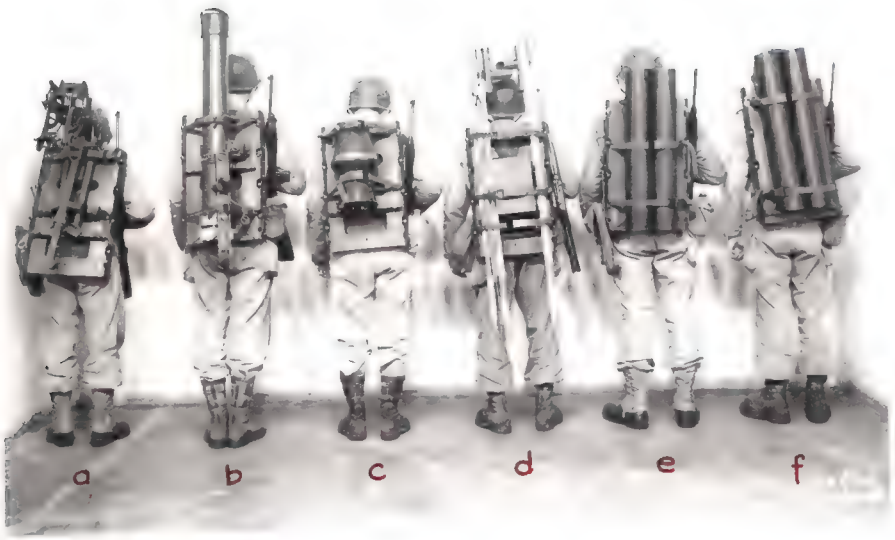

4.2 inch Recoilless Howitzer on packboard as discussed in Test No. 2

a - Packboard Load No. 1

b - Packboard Load No. 2

c - Packboard Load No. 3

d - Packboard Load No. 4

e - Packboard Load No. 5

f - Packboard Load No. 6

Figure 4

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4.2 inch Recoilless Howitzer on packboards.

Front view of loads shown in Figure 3.

Figure 5

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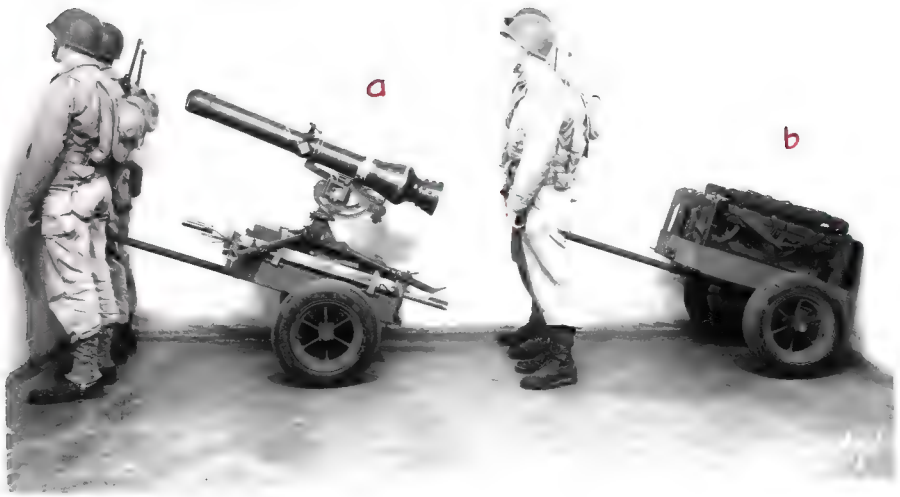

4.2 inch Recoilless Howitzer on Handcarts M3A4 as discussed in Test No. 2.

a - Cart No. 1

b - Cart No. 2

Figure 6

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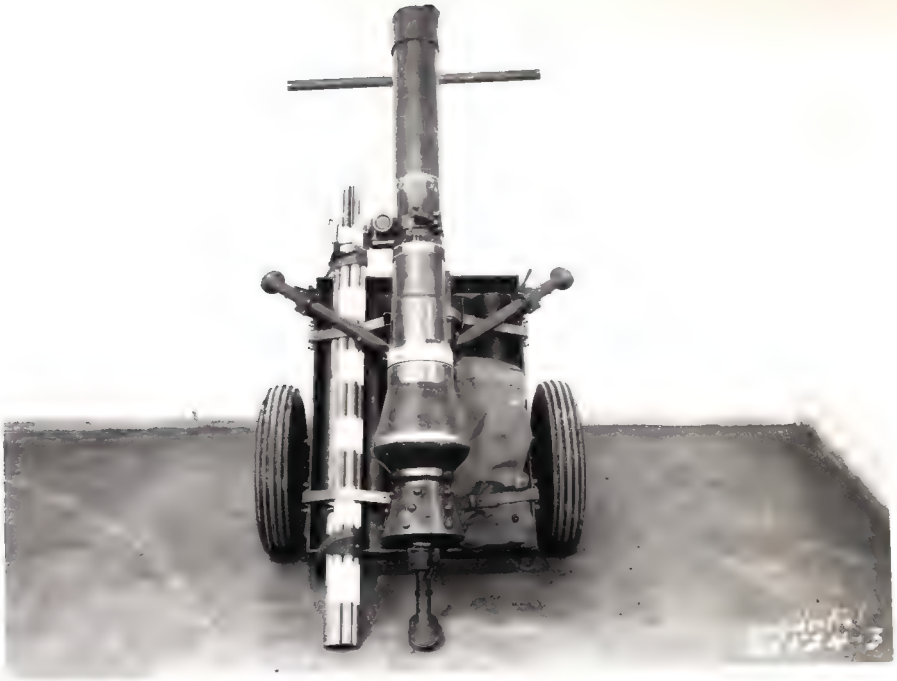

4.2 inch Recoilless Howitzer in Hand Cart, M3A4.

Top view of Cart No. 1 shown in Figure 6a.

Figure 7

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Test No. 3

a. Purpose:

(1)* To determine the personnel necessary to form a suitable gun crew for transporting and operating the subject weapon.

(2)* To develop a suitable gun drill for the subject weapon.

*Distinctly tentative based on test operational requirement.

(3) To determine the speed of assembly and disassembly of the subject weapon.

b. Method: By study of the materiel breakdown, training of the crew, and recording of the time for going into and out of action.

c. Results:

(1) GUN CREW. The size of the gun crew is to a great extent governed by the breakdown of the gun for carrying. The following crew and component loads have been developed:

Crew Member	Component Load
Sqd Ldr	None
Gunner (No. 1)	Assembled Tripod and Cradle
Asst Gunner (No. 2)	Barrel and pintle bracket
No. 3	Reaction chamber
No. 4	Sight and accessories
No. 5	Ammunition (2 rds)

(2) GUN DRILL. A basic gun drill was developed for the purpose of determining possible assembly speed of the howitzer and mount. This drill may be further developed for training. Drill follows:

After Squad Leader has selected the position and calls "Action" the following action occurs:

(a) Gunner brings up assembled tripod and cradle with trail leg adjusted approximately correct. Holding the pintle housing with his left hand he loosens the front legs, grasps the trail leg with his right hand and swings the front legs forward and open. Holding the dial

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approximately level, he locks the front legs. Rotating the tripod so that the trail leg points forward in the direction of fire, he seats the tripod and stamps in the feet of the triped legs. He then assumes a kneeling position on the left of the mount and pulls the lock pin for the reaction chamber and elevating bracket pin.

(b) Assistant gunner brings up the barrel and sets it in the cradle. Gunner lifts pintle latch until pintle is seated, and replaces elevating bracket pin.

(c) No. 3 brings up the reaction chamber and hands it to the assistant gunner who places it on the barrel and screws it into place. The gunner replaces the detent pin when the reaction chamber is in place.

(d) No. 4 brings up the sight and hands it to the gunner who places it on the sight bracket. Sight and gun are then adjusted approximately level. Gunner calls "Up".

(3) Assembly time. Using the above gun drill the howitzer can be assembled from the packboard loadings in 55 to 70 seconds. Assembly time from mounted gun to packboards averaged 105 to 125 seconds.

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Test No. 4

a. Purpose: To determine the effective rate of fire of the 4.2 Recoilless Howitzer.

b. Method: By study and trial of different systems of crew firing.

c. Results:

(1) A system of rapid fire was developed by Allegany Ballistics Laboratory with which they were able to attain a rate of fire of ten rounds per minute. This system utilized a line of men preparing and passing shells to the gunner and involved too great a number of men at the gun for the security of the crew.

(2) Relaying for each round. It was found that the Telescope, M62, did not retain its position during firing and had to be readjusted to the index between rounds. Using this method, a rate of fire of two rounds per minute was obtained.

(3) Adjusting after first round only. The best results were obtained by preparing all rounds for a given mission prior to the start of firing, adjusting from observation of the burst of the first round and then firing the balance of the mission without further adjustment. With this method a rate of fire of 6 rounds per minute was obtained with a lateral spread of approximately 10 mils on targets at 1800 yards.

(4) High angle fire without driver. At angles of elevation from 250 to 500 mils firing rates equivalent to those obtained with the standard mortar are possible. At angles of elevation above 500 mils the backblast strikes the ground behind the howitzer at such an angle as to cause violent blast effect around the howitzer and necessitates the use of the lanyard and yoke for firing. Adjusting the yoke reduces the rate of fire to approximately 3 rounds per minute.

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Test No. 5

a. Purpose: To determine the accuracy of the 4.2 Recoilless Howitzer and check the accuracy of angles of elevation given in provisional firing tables.

b. Method:

(1) Firing was conducted at 300 and 500 yards on vertical panels. Shot groups were measured and recorded.

(2) Firing was conducted at provisional angles of elevation for ranges of 600, 1200, 2000, 2500, 3000, 3500 and 3735 (Max.) yards. Length and width of ground strike patterns were recorded.

(3) Firing was conducted at maximum recommended elevation, 1065 Mils. Length and width of ground strike pattern was recorded.

(4) Five round groups were fired at each range.

c. Results:

(1) 300 and 500 yards. Results of firing tabulated below:

Range	Elevation Table	Elevation Actual	Max. Vert.	Max. Hor.	Max. Spread
300	29.2 M	31M	13 in.	14 in.	14 in.
500	49.8 M	52 M	36 in.	50 in.	54 in.

(2) Provisional angles of elevation for 600, 1200, 2000, 2500, 3500, and 3735 yards. Results of firing as tabulated below:

Firing Data from FT 4.2-D-0*		Resulting Ground Pattern		
Range	Elevation	Group Length	Group Width	Av. Range
600	60.4 M	70 Yds.	5 Yds.	527 Yds.
1200	128.9 M	84 Yds.	4 Yds.	1000 Yds.
2000	236.6 M	140 Yds.	18 Yds.	1600 Yds.
2500	318.7 M	188 Yds.	9 Yds.	2428 Yds.
3500	556.1 M	108 Yds.	34 Yds.	3441 Yds.
3735	751.2 M	460 Yds.	45 Yds.	3786 Yds.

*Firing Table for 4.2 inch Recoilless Chemical Mortar.

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(3) Maximum recommended elevation. Maximum elevation recommended by Chemical Warfare Service representative was 1065 mils or approximately 60 degrees. The average range at this elevation was 2888 yards with a ground group 125 yards long and 285 yards wide.

(4) During the test firing it was found that between 150 mils and 250 mils elevation the slope of the barrel was too steep to permit the shell to rest in the muzzle while pulling the driver firing pin but not steep enough to allow the shell to slide down the bore with sufficient velocity to fire. At 150 to 250 mils it was found necessary to hold the shell with one hand while preparing to pull the driver firing pin. In pulling the driver firing pin, both hands are withdrawn from the shell at the same time.

(5) At elevations from 250 to 500 mils firing could be accomplished without the driver by dropping the shells down the barrel in the normal manner for mortar firing.

(6) Above 500 mils it becomes necessary to use the 4.2 inch Chemical Mortar firing lanyard and fork due to the excessive blast pressure around the howitzer induced by the blast being directed at the ground. Use of the lanyard requires sliding the fork onto the shell just below the bourrelet, the fork resting on the muzzle and the bourrelet of the shell resting on the fork. The shell is then dropped by a pull on the lanyard attached to the fork.

(7) At angles of elevation of 751 mils and greater it was found that there was a slight forward jump in the mount when the round was fired. Observation indicated that the weight of the shell striking the firing pin tipped the mount rearward, raising the front leg of the mount. Upon firing the pressure developed by blast being directed at the ground at the rear of the howitzer tipped the howitzer forward and raised the rear legs of the mount off the ground. During the raising of the legs, the mount moves forward 1-1/2 to 2 inches.

(8) During the firing it was noted that the driver, upon departure of the shell from the barrel, became a separate and distinct projectile with ballistic characteristics that were not comparable to those of the shell. When the weapon was being fired at a range of 600 yards the drivers were observed to strike the ground at approximately 300 yards. At a range of 1800 yards the drivers struck the ground at approximately 650 yards.

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Test No. 6

a. Purpose: To determine the effect of the Shell, HE, E74, on earth and log bunkers, or pill boxes of the Japanese type.

b. Method: The Shell, HE, E74, was fired from the 4.2 inch Recoilless Howitzer at a pill box of earth and log construction at a range of approximately 100 yards. Results of impact were noted and recorded.

c. Results:

(1) The first round fired entered the pill box above the embrasure without detonating. The second round entered the embrasure without detonating.

Note: At this point in the test, firing was discontinued to determine the cause of failure to detonate. After determination of cause of failure (see Test No. 7) firing was continued in this test.

(2) Continuing the firing:

(a) The first round penetrated above the embrasure. Detonation was questionable.

(b) The second round penetrated between the ceiling logs and the top of the embrasure. The top of the pill box was observed to jump although no report was heard. Investigation disclosed that a log from the front wall had been blown into the corridor of the pill box.

(c) The third round penetrated between the layers of ceiling logs. Detonation blew out the roof of the pill box, forming a crater in the roof 15 feet in diameter and 4 feet deep. A hole was also blown through the lower layer of ceiling logs and fragments were imbedded in the inner walls of the pill box.

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Test No. 7

a. Purpose: To determine and remedy the cause of fuze malfunctions in the 4.2 inch Shell, HE, M74.

b. Method: By firing with varying conditions of impact and examination and study of any duds so obtained.

c. Results:

(1) Ricochet fire. Aiming at a point on the ground at approximately 200 yards range, three ricochets were obtained, two of which were air bursts, one at 225 yards and one at 250 yards, and the third of which detonated in a pile of soft earth at 200 yards.

(2) Earth and logs. Firing was continued at a demolished earth and log pill box at approximately 75 yards range. The first four rounds detonated in the soft earth. The fifth round was questionable. The sixth round detonated. The seventh round detonated and unearthed the fifth round, which had not detonated.

(3) Examination of dud. It was found that the driver adapter, which contains the firing pin, was breaking off the fuze. This breaking off of the adapter appeared to be due to clearance beneath the adapter and insufficient strength in the fuze shoulder. The combination of these permitted the adapter threads to shear. Upon impact with a hard surface (log), the fuze shoulder crushed until the adapter bottomed in the counter-bore. This was sufficient to allow the threads to shear.

(4) Remedy. Washers of the proper diameter were cut from 1/32 inch thick Vellumoid gasket material. The adapters were removed from ten rounds and reassembled with the washers between the adapter and the bottom of the fuze counter-bore.

(5) Results of firing corrected fuzes. The second phase of firing in Test No. 6 was then completed successfully and the balance of the modified rounds were used in the accuracy tests, all rounds detonating successfully.

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Test No. 8

a. Purpose: To determine the cratering and fragmentation characteristics of the Shell, HE, E74.

b. Method: By examination of impact areas after firing tests.

c. Results:

(1) Cratering. The type of cratering obtained with the E74 Shell is dependent upon the type of soil, and the height of fall of the shell. Craters obtained at mid-range (1800 yards) in sand-clay loam were approximately 4 to 5 feet deep and 11 to 14 feet in diameter. Additional cratering data with respect to earth and log bunkers are contained in Test No. 6.

(2) Fragmentation. Fragments collected in impact areas have varied in size from 1/4" x 1" to 1" x 10". Edges of the fragments were serrated and very sharp. Since the shell is equipped with a delay fuze no tests were conducted to determine the effect of the fragmentation cone.

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Test No. 9

a. Purpose: To determine the feasibility of direct and indirect laying with the subject weapon.

b. Method: By study of firing conducted for accuracy in Test No. 5 as follows:

(1) The 300 and 500 yard firing was conducted by direct laying.

(2) The 600 to 3735 yard firing was conducted by indirect laying.

c. Results:

(1) Direct laying. Although the E19 sight furnished with the weapon is basically constructed for indirect laying, it can be used for direct laying. The procedure consists simply of zeroing the telescope (M62) in the adapter (M9), adjusting the range quadrant to the elevation required for the range and laying the cross hairs of the telescope directly on the target with the sight cross leveled. The longitudinal bubble is ignored in this case since angle of site is compensated for by directly laying the cross hairs on the target. Using this method it was possible to obtain the 300 and 500 yard groups shown in Test No. 5. The sight, however, must be very carefully bore sighted and the M62 telescope carefully indexed.

(2) Indirect Laying. Indirect laying with the E19 sight is accomplished by laying the sight on a suitably located aiming post, after applying the required quadrant elevation and proper deflection to the sight scales, with the longitudinal and cross levels leveled. This method of laying the weapon was employed in obtaining the accuracy groups at 600 to 3735 yards in Test No. 5.

(3) In either type of firing the sight must be removed immediately after laying the weapon and before firing to avoid disturbance of the sight settings. It was found that, although the weapon does not recoil, it is subject to spasmodic vibration, during the departure of a round, which disturbs the elevation and deflection scales on the sight and causes the elbow telescope to tip backward.

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Test No. 10

a. Purpose: To determine the feasibility of firing the subject weapon at moving targets.

b. Method: By study of the weapon, the mount, the sights, the method of loading and firing and by manipulation of the weapon.

c. Results:

(1) The first requirement in moving target firing, with regard to the mount, is a free pintle or rapidly manipulable traverse and rapid elevation adjustment. The 1917A1 machine-gun cradle has a very slow and limited elevation adjustment in its elevating handwheel. Although the weapon can be fired with a free pintle, the method of firing (pulling the driver pin) does not lend itself to firing without disturbing the lay prior to departure of the shell.

(2) The sight is basically an indirect fire sight. The reticule is equipped with cross hairs rather than range graduations. This requires estimation of range, adjustment of the sight and adjustment of the weapon for elevation and then laying on the moving target, all of which in itself, precludes its use on moving targets except under very favorable conditions.

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Test No. 11

a. Purpose: To determine the position disclosure characteristics of the 4.2 inch Recoilless Howitzer.

b. Method: By observation and comparison with other Infantry weapons, namely, the 105mm Howitzer, M3; the 57mm Anti-Tank Gun; and, the 57mm Recoilless Rifle.

c. Results:

(1) The 4.2 inch Recoilless Howitzer has flash, smoke and dust raising characteristics in excess of any other Infantry weapon except the 57mm Antitank Gun. The blast of the subject weapon is directed to the rear and downward in direct opposition to present conventional weapons. The muzzle flash is of such slight proportion as to be completely lost in the tremendous breech blast.

(2) Night observation has disclosed that the flash is clearly discernible (air line) at a distance which is in excess of the average operating range of the weapon. When observed at ranges of 2700 yards and less from behind a mask, the flash appears to light up the greater portion of the horizon with sufficient brilliance at the middle of the aura to permit close estimation of the direction to the weapon.

(3) Figures 8 to 15 disclose that the 4.2 inch Recoilless Howitzer has a greater flash than the 57mm Recoilless Rifle or the 105mm Howitzer, but has less flash than the 57mm Antitank Gun.

(4) The dust raising characteristics are greater than those of the 57mm Recoilless Rifle due to a greater volume of blast and greater than those of the 105mm Howitzer and 57mm Antitank Gun due to blast direction. Figures 16 and 17 show the dust raising characteristics of the subject weapon at a high angle of elevation and mounted on hard clay and the hole in the ground from the backblast. In this case, large lumps of clay have been blown from the ground behind the weapon.

(5) Smoke characteristics of the subject weapon are greater than those of the 57mm Recoilless Rifle and 105mm Howitzer. They are about equal to those of the 57mm Antitank Gun but do not interfere with gunner observation as much as on the 57mm Antitank Gun due to the greater part of the smoke being projected to the rear.

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4.2 inch Recoilless Howitzer as seen at night from 400 yards distance when fired.

See Figures 10, 12, and 14 for comparison with other weapons.

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Figure 8

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4.2 inch Recoilless Howitzer viewed at night from 75 yards when fired.

See Figures 11, 13 and 15 for comparison with other weapons.

Figure 9

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105mm Howitzer, M3, viewed at night from 400 yards when fired with Charge 3.

Flash was not sufficient to register on photographic film.

Figure 10

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105mm Howitzer, M3, as viewed at night from 75 yards when fired with Charge 3.
Flash was not sufficient to register on photographic film.

Figure 11

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57mm Recoilless Rifle as viewed at night from 400 yards when fired.

Figure 12

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57mm Recoilless Rifle as viewed at night from 75 yards when fired.

Larger flash is breech flash.

Figure 13

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57mm AT Gun as viewed at night from 400 yards when fired.

Figure 14

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57mm AT Gun as viewed at night from 75 yards when fired.

Figure 15

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4.2 inch Recoilless Howitzer mounted on hard clay firing at approximately 60° elevation. Note the large clods of clay thrown into the air by the backblast.

Figure 16

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Hole caused by backblast of 4.2 inch Recoilless Howitzer shown firing in Figure 16.

Figure 17

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Test No. 12

a. Purpose: To determine the heating of the subject weapon and ease of handling while hot.

b. Method: By observation and study during firing tests.

c. Results:

(1) The design of the barrel and reaction chamber of the subject weapon are such as to induce rapid cooling. The walls of the barrel and reaction chamber are thin and the open breech allows for constant circulation of air and its attendant cooling action.

(2) When firing at a slow rate (re-laying for each round), it was found that the barrel and reaction chamber heat very slowly. Fifteen to eighteen rounds can be fired in this manner before the barrel becomes too hot to touch with the bare hand.

(3) When firing at a rapid rate (re-laying after the first round only, followed by continuous fire), it was found that the barrel and reaction chamber were too hot to touch with the bare hand after six rounds had been fired. In this case little opportunity for cooling is offered between rounds.

(4) Handling the weapon while hot requires the use of gloves, preferably of the standard asbestos type. It is possible to carry the weapon out of position by grasping the legs of the tripod mount; however, even then it is sometimes necessary to grasp the barrel for balancing. Disassembly of the hot weapon cannot be accomplished without protection for the hands.

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Test No. 13

a. Purpose: To determine

(1) The feasibility of using standard 4.2 inch Chemical Mortar ammunition in the subject weapon.

(2) The feasibility of converting the subject weapon to a standard 4.2 inch Chemical Mortar by use of the standard mortar base cap, base plate, etc.

b. Method: By study of the ammunition and weapons.

c. Results:

(1) In order to utilize the recoilless principle, the 4.2 inch Shell, E74, is equipped with approximately 3.5 lbs. of standard mortar shell propellant. This propellant is secured to the shell by a flame and moisture resistant cover. In comparison, the standard 4.2 inch mortar shell utilizes less than 1/2 lb. of standard mortar shell propellant at maximum charge. This difference in propelling charges precludes the use of the standard 4.2 inch mortar shell in the subject weapon.

(2) Although the barrel for the 4.2 inch Recoilless Howitzer was made from the standard 4.2 inch Chemical Mortar barrel, it has been sufficiently altered to prevent its reconversion to standard. The threads on the breech are different than those for the standard breech cap and mounting bracket rings have been added to the barrel.

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Test No. 14

a. Purpose: To determine the functioning of the 4.2 inch Recoilless Howitzer and ammunition.

b. Method: By study of the howitzer and ammunition during the firing tests.

c. Results:

(1) The Howitzer.

(a) Throughout the firing tests all parts of the howitzer functioned without failure.

(b) It was found that the cradle on the tripod mount was not entirely adequate for the weight of the howitzer. The barrel, reaction chamber and sight weigh approximately 135 lbs.; add to this a shell weighing approximately 28.5 lbs. placed in the muzzle of the howitzer and the result is a load 4 times as heavy as the load for which the cradle was designed. The cradle is held in the vertical plane by a friction clamp on the side of the cradle. This clamp must be excessively tight to hold the howitzer in position during firing. In one firing situation, the barrel was pulled downward by the gunner while pulling the firing pin, and the round ricocheted off the ground at approximately 50 yards and burst at 85 yards. In this case it is not known whether the clamp was not drawn tight enough or jarred loose during previous firing. It is known that when fired the howitzer undergoes a severe spasm.

(c) As disclosed in Test No. 5, there is a range of angles of elevation through which the shell must be held in place in the muzzle of the howitzer as the driver pin is pulled, or if the driver is not used, the shell must be thrown down the barrel to obtain ignition. The angle of elevation at which the change-over from driver firing to drop firing occurs is not clearly defined. These elevations range from 150 mils to approximately 250 mils. If drop fired at these elevations the result is likely to be an unfired shell that will have to be removed from the barrel before firing the next round.

(d) Throughout the firing there were several instances in which the firing pin could not be completely withdrawn from the driver. This was found, in all cases, to be due to sharp edges of the firing pin hole cutting into the firing pin.

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(e) There was only one instance of a driver bursting when the firing pin was pulled. The body of the driver split open upon ignition without driving the shell back into the barrel. The cause of this failure is not known.

(f) It was found that the shear pins in the driver assembly were not of sufficient strength to permit transportation of the shell with the driver assembled to it. The shock of transportation jolting was sufficient to cause the drivers to break off.

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Test No. 15

a. Purpose: To determine the suitability of the sight furnished with the 4.2 inch Recoilless Howitzer.

b. Method: By observation and study of the sight in firing tests.

c. Results:

(1) Throughout the firing tests it was found necessary to remove the sight during the firing of a round to prevent disturbance of the sight settings. Although there is no forward or rearward displacement of the howitzer during firing, a vibration "spasm" occurs within the weapon which reflects itself in the sight.

(2) Any one, or all, of three things will occur to the sight when the weapon is fired:

(a) The Elbow Telescope, M62, will tilt backward. This occurs each time the weapon is fired with the sight in place. If the sight has been boresighted for direct laying prior to firing, the "zero" is lost in the tilting of the telescope.

(b) The deflection micrometer knob on the Telescope Adapter, M9, jumps off its setting. Deflection jumps as high as 90 mils have been noted.

(c) The elevation micrometer knob on the Elevation Quadrant, T13, jumps off setting. This is the rarest of the sight disturbances and only a few such conditions have been noted, the extreme of which was 6 mils.

(3) Basically, the Sight, E19, is an "indirect laying" sight and is not well adapted for direct laying. With the subject weapon speed of fire is essential when directly engaging targets. The necessary removal of the sight between rounds materially interferes with speed of laying on such a mission. Until such time as a suitable direct fire sight, with a graduated reticule is provided, the method of fire used in Test No. 4, par c(3), will provide the best accuracy for high rates of fire.

(4) Since all features of the sight are designed on the basis of indirect laying, the sight is suitable in that respect except for the inability of the sight to withstand the shock of firing.

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Test No. 16

a. Purpose: To determine the suitability of the spare parts, tools and accessories furnished with the 4.2 inch Recoilless Howitzer.

b. Method: By study of use of the spare parts, tools and accessories during firing tests.

c. Results:

(1) Tools, spare parts and accessories received with the subject weapon were, in themselves, suitable and adequate.

(2) Since receipt of the subject weapon, spare parts, tools and accessories by this agency, Technical Bulletin CW 24, subject "4.2 inch Recoilless Chemical Mortar", has been published. This publication includes a list of accessories having items in addition to those received with the weapon and with one exception covers all accessories believed to be essential additions to those received.

(3) It is believed that in addition to the accessories listed in TB CW 24, a machine-gun clinometer should be supplied for adjusting the elevation scale on the elevation quadrant and to permit laying the weapon for elevation in the event of damage to the sight.

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Test No. 17

a. Purpose: To determine the feasibility of using the subject weapon in battery fire.

b. Method: By study of the weapon in firing tests and in the light of previous studies on battery fire.

c. Results:

(1) Under Report of the Infantry Board No. 1612, tests were conducted in battery fire with 81mm mortars. The sight offering the most accurate facilities for paralleling mortars in battery was one designated Elevation Quadrant, T13. This is exactly the same sight as furnished with the subject weapon and designated Sight, E19.

(2) The Adapter, M9, on which the Telescope, M62, is mounted has a full 6400 mil traverse, and with the weapon at "0" elevation, the telescope can be traversed the full 6400 mils without obstruction in the field of view. This permits mutual laying with an O.P. or with other weapons. All of this combines to make battery fire with the subject weapon entirely feasible.

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Test No. 18

a. Purpose: To determine the durability of the subject weapon.

b. Method: By observation and frequent examination of the weapon during the foregoing tests.

c. Results:

(1) In the test firing a total of 91 rounds were fired. At this time it was found that the restricting plug was badly eroded, the edge of the powder support plate was eroded slightly and the surface checked. The howitzer had developed a slight forward reaction. Replacement of the powder support plate and restricting plug rebalanced the weapon.

(2) In the towing tests the lunette on the M3A4 cart became bent due to the load rocking from side to side. It appears that, for the load involved, the lunette is not sufficiently rigid for vehicular towing. No other damage was incurred by the cart.

(3) Throughout the test the weapon was transported, both assembled and disassembled, in motor vehicles and in trailers. Examination at the conclusion of the tests disclosed no damage to the howitzer or the mount. The case in which the sight is carried appears to afford adequate protection.

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Test No. 19

a. Purpose: To determine the desirable modifications to the subject weapon and ammunition.

b. Method: By observation and study of the weapon during firing tests.

c. Results:

(1) The Howitzer. The top of the barrel should have machined "flats" for seating a machine-gun clinometer. The clinometer is necessary for zeroing sight scales and for laying elevation in the event of damage to the sight.

(2) The Mount.

(a) The rigidity of the mount should be increased. The present cradle is much too light and "springy" for the load carried. The weight of the shell in the muzzle deflects the barrel sufficiently to require laying the weapon with the shell in the muzzle. At the same time the weight must be kept at a minimum; therefore, it appears that the requirement is for a cradle of light material, such as aluminum alloy, and adequate shape and thickness for strength.

(b) Both the elevation and deflection adjustments should be rapid and have positive locking characteristics. The present elevation lock is a friction clamp. The deflection on the present mount can be adjusted around two pintles, i.e. the coarse adjustment around the cradle pintle and the fine adjustment around the mounting bracket pintle. At high angles of elevation, leveling of the sight is very difficult when using the fine adjustment and is usually accomplished by loosening the cradle pintle clamp and tapping the howitzer into alignment and at the same time adjusting the sight bracket. It is possible that the design used in the elevating and traversing mechanism on the mount, T10E2, for the 37mm Gun, T33, might be adapted to this weapon.

(3) The Sight. The E19 sight should be modified to have sufficient rigidity to withstand the shock of firing without tilting of the telescope or loss of setting on the elevation and deflection scales. For direct laying the sight should have a graduated reticle for ranges up to 1500 yards. The telescope should have "zeroing" stops to permit bore sighting. If it is found to be not feasible to incorporate the direct laying features into the Sight, E19, the sight bracket should be modified to carry an additional sight similar to the Telescope, T126, with an appropriate reticule.

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(4) Ammunition.

(a) The driver rocket should be modified to permit the shell, with driver attached, to be transported without breakage of the driver. At present the shear pins in the driver separation rings, shear, due to transport jolting.

(b) The driver firing pin should be of such design and material as to prevent sticking during attempted firing. Several instances of the pin sticking when partially pulled have been noted during the tests.

(c) The fuse should be redesigned to prevent shearing of the threads in the delay element and the attendant separation from the fuse when striking a solid object. Super-quick and time elements should be incorporated in the fuze or should be furnished as a separate combination fuse.

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Test No. 20.

a. Purpose: To determine the effect of storage at extremely high and extremely low temperatures on the subject ammunition.

b. Method: Five rounds were stored for 18 hours in a temperature of +120°F. and five rounds were stored for 18 hours in a temperature of -5°F. The rounds were fired and the reaction of the weapon observed.

c. Results:

(1) Hot Rounds. There was no apparent difference in the reaction of the weapon to the hot ammunition than to ammunition at normal temperature. The sound of the backblast seemed to be slightly more brusque than that of ammunition at normal temperature.

(2) Cold Rounds. There appeared to be a very slight forward impulse in the weapon when the cold rounds were fired. It was not sufficient, however, to displace the mount. The report seemed to be slightly louder and of longer duration than that of ammunition at normal temperature.

(3) Both hot and cold driver rockets appeared to function normally.

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Test No. 21

a. Purpose: To determine the effect of immersion of the subject shell and driver rocket in water.

b. Method: An M74 shell and driver were submerged in water for two hours and then examined.

c. Results:

(1) Examination disclosed that the tape which seals the cardboard propellant case had soaked loose; water had soaked through the sides and ends of the cardboard case. The ends of the powder were wet and water had soaked the forward end of the igniter tube on which the propellant powder discs are assembled.

(2) The interior of the driver rocket was completely dry.

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5. Summary of Facts Disclosed by the Foregoing Tests:

a. The foregoing tests have disclosed the following:

(1) The subject weapon has the following physical characteristics (in comparison to the 105mm Howitzer, M3): (Test No. 1)

Characteristic	4.2" Rec. How.	105mm How., M3
Weight on carriage (Mount)	180.0 lbs.	2495.0 lbs.
Weight on Cart M3A4 with 5 rds.	507.0 lbs.	————
Height, Overall	28.0 in.	44.0 inl
Length, Overall	53.7 in.	155.0 in.

(2) The Shell, HE, M74, for the subject weapon has the following characteristics (in comparison to the Shell, HE, M1 for 105mm Howitzer, M3): (Test No. 1)

Characteristic	4.2" Shell, M74.	105mm Shell, M1
Weight, complete Rd.	28.2 lbs.	40.5 lbs.
Length, complete Rd.	31.0 in. (w/driver)	31.07 in.
	27.0 in. (w/o driver)	————
Weight HE Charge	8.5 lbs.	4.8 lbs.
Muzzle Velocity	715 f/s	1020 f/s. (Ch 5)
Max. Range	3735 yds.	8295 yds.

(3) The subject weapon and ammunition can be successfully transported by packboard, M3A4 hand cart, or motor transport. On the basis of loading for one complete weapon unit, the following load weights were obtained: (Test No. 2)

(a) Packboard (included in loads)

1. Weapon, Spare parts, tools and accessories comprising:

Load No. 1	57.25 lbs.
Load No. 2	77.50 lbs.
Load No. 3	65.50 lbs.
Load No. 4	56.00 lbs.

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2. Ammunition (2 Rds per packboard) 68.25 lbs.

Note: All packboard loads excessive, except for very short distances on easily traversable terrain.

(b) Hand Cart, M3A4. (included in loads)

1. Hand Cart No. 1 (includes weapon complete and 5 rds ammunition) 507.00 lbs.

2. Hand Cart No. 2 (10 rds ammunition and 5 packboards) 464.25 lbs.

(c) Motor Transport (1/4-ton trailer; weight of trailer not included)

1. Trailer No. 1 (includes Hand Cart No. 1 and load plus 5 rds ammunition) 662.00 lbs.

2. Trailer No. 2 (includes Hand Cart No. 2 and load plus 5 rds ammunition) 619.25 lbs.

(4) The gun crew required for successful transport and operation consists of a Squad Leader and 5 men, one of which is an ammunition bearer. Additional ammunition bearers will be required to fit the situation. (Test No. 3)

(5) With the above crew the subject weapon can be assembled from packboards in 55 to 70 seconds. Remounting on the packboards required 105 to 125 seconds. (Test No. 3)

(6) Using the driver on the shell, an effective rate of fire of 6 rounds per minute was attained. In drop firing the rate of fire is comparable to that of a conventional mortar. (Test No. 4)

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(7) The ranges obtained were generally about 10% less than those specified in provisional firing tables for the elevations used. The following accuracy data was obtained: (Test No. 5)

(a) Vertical Targets

Range	Max. Vert.	Max. Horiz.	Max. Spread
300	13 in.	14 in.	14 in.
500	36 in.	50 in.	54 in.

(b) Ground Targets

Range Specified	Group Length	Group Width	Obtained Average Range
600 yds.	70 yds.	5 yds.	527 yds.
1200 yds.	84 yds.	4 yds.	1000 yds.
2000 yds.	140 yds.	18 yds.	1600 yds.
2500 yds.	188 yds.	9 yds.	2428 yds.
3500 yds.	108 yds.	34 yds.	3441 yds.
3735 yds.	460 yds.	45 yds.	3786 yds.

(c) Maximum Recommended Elevation

Angle of Elevation	Group Length	Group Width	Average Range
1065 mils	125 yds.	285 yds.	2888 yds.

(8) Between 150 mils and 250 mils angle of elevation the shell will slide down the barrel of the weapon, but without sufficient force to actuate the propellant primer. If the driver is used, the shell must be held in the muzzle with the hand while the pin is pulled with the other. If the driver is not used the shell must be thrown down the barrel. (Test No. 5)

(9) From 250 to 500 mils angle of elevation the shell can be dropped down the barrel to fire. (Test No. 5)

(10) Above 500 mils it is necessary to use the lanyard and fork for safe firing. (Test No. 5)

(11) Firing at angles above 751 mils is impractical due to mount jump caused by the backblast. (Test No. 5)

(12) The driver becomes a separate projectile with a range much less than that of the shell. At 600 yards for the shell the driver

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strikes at about 300 yards and at 1800 yards for the shell, the driver strikes at about 650 yards. (Test No. 5)

(13) The Shell, HE, E74, is highly effective against earth and log pill boxes of the Japanese type. (Test No. 6)

(14) Excessive clearance in the machining of the fuze body and driver adapter caused shearing of the adapter threads and separation of the adapter and fuze upon impact with a solid object. (Test No. 7)

(15) At mid-range (1800 yds. approximately) the Shell, E74, makes craters 11 to 14 feet across and 4 feet deep in sand-clay loam. (Test No. 8)

(16) The E74 Shell bursts into fragments varying from 1/4" x 1" to 1" x 10" with sharp serrated edges. (Test No. 8)

(17) Both direct and indirect laying are possible with the E19 sight. However, for direct fire the sight must be very carefully bore-sighted and the Elbow Telescope, M62 carefully zeroed on its index. (Test No. 9)

(18) The sight must be removed between rounds to prevent disturbance of sight settings due to barrel vibration. (Test No. 9)

(19) Moving target firing may be done under very favorable conditions with the subject weapon; however, it is not practical as a general practice. (Test No. 10)

(20) The subject weapon has flash, smoke and dust-raising characteristics in excess of any other Infantry weapon except the 57mm Antitank Gun. (Test No. 11)

(21) The barrel re-cools rapidly when fired at a slow rate, but will become too hot to touch in six rounds of rapid firing and should only be disassembled with protected hands. (Test No. 12)

(22) The use of standard 4.2 inch Chemical Mortar ammunition in the subject weapon or conversion of the subject weapon to a standard 4.2 inch Chemical Mortar are not feasible. (Test No. 13)

(23) All parts of the subject weapon functioned without failure throughout the tests. (Test No. 14)

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(24) The firing pin in the driver rocket was found to stick when partially pulled in several instances due to sharp edges of the firing pin hole cutting into the pin. (Test No. 14)

(25) In one instance the body of a driver burst upon withdrawing the firing pin. (Test No. 14)

(26) The shear pins of the driver rocket are not sufficiently strong to permit transport of shells assembled with drivers without separation of the driver from the shell. (Test No. 14)

(27) The Sight, E19, is not sufficiently sturdy to withstand the shock of firing. (Test No. 15)

(28) Spare parts, tools and accessories furnished with the subject weapon are adequate except that a requirement exists for the inclusion of machine-gun clinometer. (Test No. 16)

(29) Use of the subject weapon in battery is entirely feasible. (Test No. 17)

(30) The restricting plug, and powder support plate should be replaced after the firing of approximately 90 rounds. (Test No. 18)

(31) The lunette on the Hand Cart, M3A4, is not sufficiently rugged to withstand vehicular towing without bending. (Test No. 18)

(32) The mount appears to be sufficiently rugged to withstand field use and transport. (Test No. 18)

(33) The subject weapon, Mount, Sight and ammunition require modification as listed in Test No. 19 to provide best performance. (Test No. 19)

(34) Extremes of temperature up to +120°F. and down to -5° F. do not materially affect the functioning of the howitzer. (Test No. 20)

(35) The cardboard cover for the propelling charge on the shells for the subject weapon is not sufficiently water resistant. (Test No. 21)

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6. Test Officer's Discussion.

a. In addition to the facts disclosed above, evaluation of the subject weapon requires consideration of its suitability to missions of close support of Infantry. Two factors enter into this consideration; the driver rocket, which, upon set back, becomes a separate projectile having a shorter range than that of the shell, and the fact that, as the restricting plug in the reaction chamber becomes eroded, there is a loss in muzzle velocity and its attendant loss in range.

(1) The driver rocket must be considered as a projectile weighing approximately .75 lb. and having a muzzle velocity of approximately 715 feet per second. It is known that the range of the driver varies from 300 yards when the shell is striking at 600 yards to approximately 650 yards when the shell is striking at 1800 yards. This means that, in overhead firing, at a range of 1800 yards the weapon would be firing a .75 lb. projectile into possible friendly troop areas at 650 yards for every round fired at the target.

(2) The actual loss of velocity and range due to wear of the restricting plug has not been determined due to lack of the proper facilities. However, study of the weapon indicates that as the volume of gas escaping from the breech increases, less volume and less pressure is available for propelling of the shell. Consequently the muzzle velocity will be reduced.

b. The outstanding advantage of the weapon is that of a weapon weighing 180 lbs. projecting an explosive charge of 8.5 lbs. as compared to a weapon weighing 2495 lbs. projecting an explosive charge of 4.8 lbs. The disadvantages, other than those discussed in 5a above, are not inherent in the principle involved, but rather in the existing material selected for conversion to expedite delivery of the weapons to using arms. It is believed that continued development will eliminate the far greater portion of the existing difficulties with the subject weapon.

c. It will be noted that the driver is packed separately from the shell in the shipping box. It is believed that, since the shells are removed from the box and carried in the cardboard tubes on packboards, the driver should be packed in the tube with the shell.

I concur in the above Record of Test:

WILLIAM J. WADE,
Major, Infantry,
Test Officer.

WILLIAM C. RUTHERFORD,
Lt. Colonel, Infantry,
Chief of Test Section.

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SECRET
From: Comdt, TIS
Date: 15 Jan 45
Initials: T. C.

HEADQUARTERS THE INFANTRY SCHOOL

Fort Benning, Georgia

15 January 1945

MEMORANDUM FOR:

Upon the request of Colonel Raymond C. Hamilton, Headquarters, Army Ground Forces, there is attached for your information, one copy of the stenographic notes on the conference convened at The Infantry School on 3 January 1945, pursuant to letter, AGF (472.8/124 (c)), 17 December 1944, subject: "Service Tests of 4.2 inch Recoilless Mortar".

Thornton Chase

THORNTON CHASE,
Colonel, A.G.D.,
Adjutant General.

APPENDIX "D"

SECRET

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RECORD of TEST

ON

SIGHTS AND OTHER ACCESSORIES FOR USE WITH THE
RECOILLESS MORTAR 4.2 INCH

TEST SECTION
THE INFANTRY BOARD

FORT BENNING, GEORGIA

**TO: THE DIRECTOR, THE INFANTRY BOARD.
HEREWITH DETAILED RECORD OF TESTS
RELATING TO THE ABOVE PROJECT.**

EDWARD B. CROSSMAN,
Lt. Colonel, Infantry,
TEST SECTION EXECUTIVE

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1. Authority and References.

a. Authority:

(1) Memorandum, The Infantry Board, IB-472, 11 August 1945. (Appendix "A")

(2) Memorandum, The Infantry Board, IB-472, 11 August 1945. (Appendix "B")

(3) Memorandum, The Infantry Board, IB-472, 16 May 1945, (Appendix "C")

(4) Memorandum, The Infantry Board, IB-472, 4 May 1945. (Appendix "D")

b. Reference: The Infantry Board Report No. 1339.

2. Introductory Information:

a. Various accessories for use with the 4.2 inch Recoilless Mortar have been developed in order to increase the overall utility of the weapon or to make use of some standard Infantry equipment on this new weapon.

b. The following items have been developed for use with the subject weapon:

(1) Modified M63 AA Mount - Two types of the mount were submitted for test.

(a) The T12 mount consists of the M63 mount with an integrally mounted elevating and traversing mechanism that may be used or disengaged as desired. The scales on this mount are graduated in degrees (Figures 1 and 2).

(b) The T13 mount consists of the M63 mount with an integrally mounted elevating and traversing mechanism that may be disengaged as desired. The scales on this mount are graduated in mils. (Figures 3 and 9)

(c) Both of the mounts as received were for use with the .50 caliber machine gun. Modification of the mount consisted of removal of the firing handles and the fabrication of an adapter to receive the mounting brackets on the three recoilless weapons. (Figures 1, 2, 3 and 9)

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NOTE: The T13 mount was broken prior to being formally tested. It was repaired and reinforced by Ordnance personnel.

(2) Lanyard Firing Device:

(a) The necessity of a device for withdrawing the firing pin from the driver rocket with a minimum reaction to the weapon was realized when accurate firing was desired. Four types of firing devices were fabricated. The first two types were discarded due to variations in construction of the driver rod.

(b) The firing device Type 3 consists of a claw device, for engaging the firing pin of the driver, hinged to a pivoted arm to increase leverage and to withdraw the claw quickly from the bore during emergence of the projectile (Figures 4 and 5)

(c) The firing device Type 4 consists of a toggle linkage which extracts the firing pin with approximate straight line motion. (Figures 6, 7 and 8)

(d) Both of these devices allow the firer to pull the lanyard of the firing device in a direction parallel to the axis of the bore, thereby reducing lateral or vertical reactions due to pulling the firing pin by hand.

(3) Sights:

(a) In order to utilize a sight now in use by the Infantry, an iron sight was fabricated which mounted over the collimator of the M4 Mortar Sight (Figure 9). This bar sight was to be used for direct fire, while the M4 Sight could still be used for indirect fire.

(b) The sight bracket for indirect fire on the 4.2" and 75mm recoilless weapons is centered at an angle of 45° above the axis of the tube of these weapons, thereby making the M4 sight usable at a minimum angle of elevation of 40°. A sight block to place the axis of the sight mount 90° to the axis of the bore was fabricated, thereby allowing the M4 sight to be used for low angle fire with 45° on the scale indicating zero elevation. (Figure 11)

(4) Moving Target Fire: The suitability of the 4.2" Recoilless Mortar for engaging moving targets had not been tested previously for accuracy and the necessary lead factor.

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(5) Indirect Fire: Due to its potential use as an Infantry weapon, the 4.2" Recoilless Mortar should be usable in the firing procedure being developed by The Infantry Board for battery fire of all Infantry weapons. The utility of the 4.2" Recoilless Mortar for indirect fire will be determined when used in an organized firing position, under a fire direction center employing the M10 plotting board. The use of the T13 sight and M4 sight with the panoramic mirror in conjunction with the above firing plan will be determined. It will also be determined if accurate fire may be delivered by use of the machine gun method, using the tripod dial and clinometer.

(6) Information on the use of the 4.2" Recoilless Mortar (and 57mm and 75mm recoilless guns) when mounted on vehicles will be found in The Infantry Board Report No. 1839.

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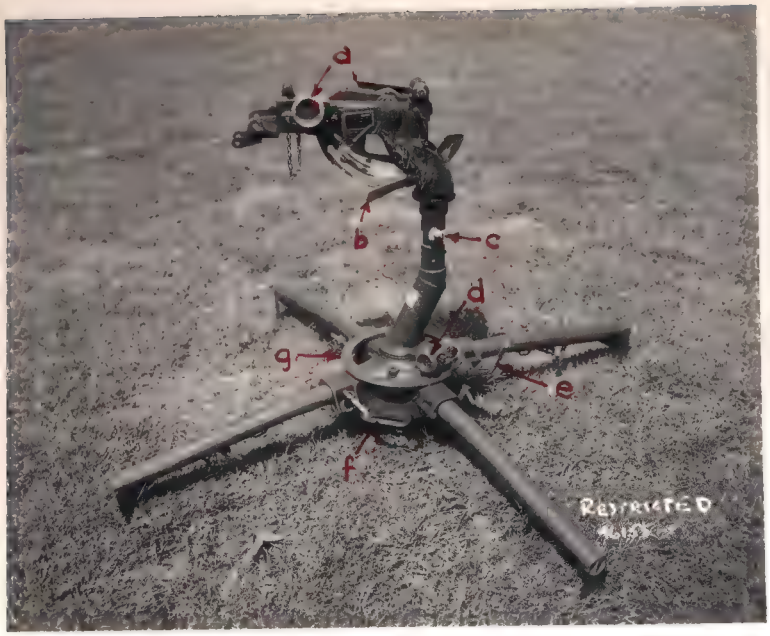

M63 AA Mount Modified - Type T12 (right side)

(Modified for mounting recoilless weapons)

a - Elevating hand wheel.
b - Elevating arc lock.
c - Pintle dismount latch.
d - Traversing hand wheel.
e - Traversing dial lock.
f - Carrying handle.
g - Traversing dial (degrees).

Figure 1

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M63 AA Mount Modified - Type T12 (left side)

(Modified for mounting recoilless weapons)

a - Traversing lock.
b - Adapter mounting lugs for weapons.

Figure 2

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M63 AA Mount Modified - Type T13 (right side), mounting the 4.2" Recoilless Mortar.

a - Elevating arc (mils)
b - Elevating hand wheel
c - Elevating arc clamp
d - Traversing dial
e - Traversing hand wheel
f - Traversing arc clamp
g - Carrying handle

Figure 3

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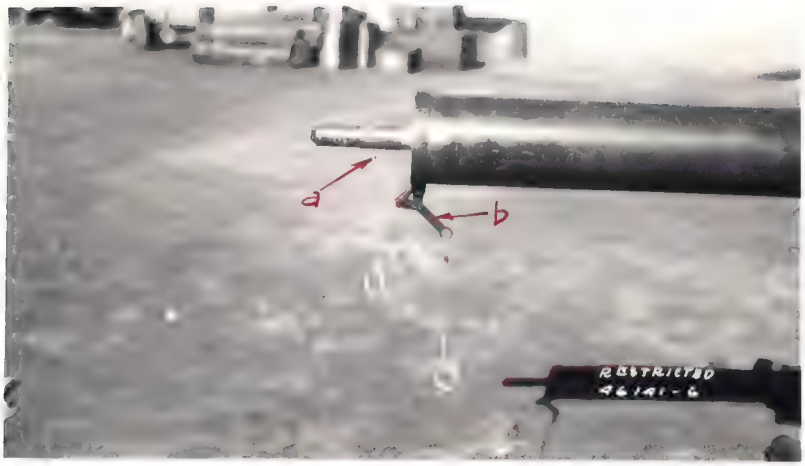

Lanyard Firing Device - Type 3

Position of device for loading and after firing.

a - Driver rocket pin and lanyard
b - Type 3 firing device

Figure 4

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Lanyard Firing Device - Type 3

Position ready for firing.

Note: The engaging claws must be held up against the driver and engaged carefully with the firing pin.

Figure 5

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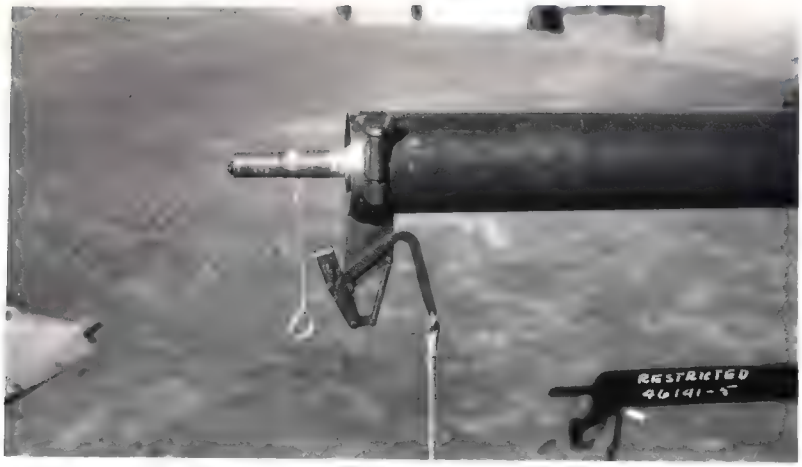

Lanyard Firing Device - Type 4

Position when loading and after firing.

Figure 6

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Lanyard Firing Device - Type 4

Position prior to engaging firing pin in device. The device is held against the driver by spring (a).

Figure 7

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Lanyard Firing Device - Type 4

Position for firing. Shell has been slipped back, engaging the firing pin in the clamp on the device.

Figure 8

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Iron sight mounted on M4 Sight. Sight is held in place by a wing nut clamp over the collimator unit.

Figure 9

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Panoramic Mirror Adapter mounted on the M4 Sight. The clamping handle for the sight mount interfered with the line of sight in one position of the sight but this difficulty could be eliminated by use of the sight extension.

Figure 10

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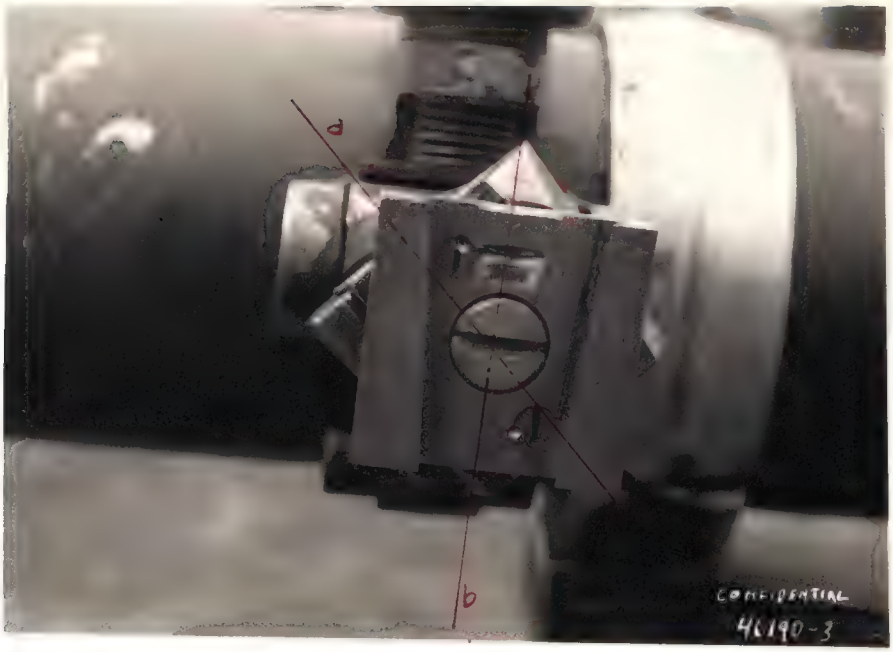

Sight mount adapter for using the M4 Sight at low angle on the 4.2" and 75mm recoilless weapons. This consists of a male and female sight block mounted at 45 deg. to correct the angle of the present sight bracket.

a - C/L of sight mount for use of telescope.

b - C/L of sight mount for use of M4 sight at low angle.

Figure 11

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3. Purpose of Test.

a. Modified Pedestal Mount M63

(1) Physical characteristics.

(2) Utility of mounting the recoilless weapons on the T12 and T13 type mounts.

b. Lanyard Firing Devices for the 4.2" Recoilless Mortar.

(1) Physical characteristics.

(2) Position of loader to observe engagement of device with firing lanyard.

(3) Speed of loading for direct laying when firing at fixed or moving targets.

(4) Disturbance of the tube when using the subject device for firing at fixed or moving targets.

(5) Practicability of firing at moving targets when using the subject device.

(6) Suitability of the subject device to hold the round in place above the point where the free shell slides into the tube.

(7) Ease of pulling the pin.

c. Attachments for the M4 Mortar Sight when used with the 75mm and 4.2 inch recoilless weapons.

(1) Modifications to utilize the M4 sight.

(2) Iron sight.

(a) Physical characteristics.

(b) Dispersion when firing direct lay at fixed targets.

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(3) Mirror adapter.

(a) Physical characteristics

(b) Utility and accuracy of the mirror adapters on the M4 sight as compared with the artillery type telescope sight when used in battery fire with other Infantry weapons.

d. Utility of using the machine gun dial and clinometer for firing the 4.2" Recoilless Mortar in battery fire.

e. Other pertinent data.

4. Details of Tests and Results.

Test No. 1 (SUPPLEMENTARY)

a. Purpose: To determine the physical characteristics of the material to be tested.

b. Method: By measuring, weighing and photographing the items to be tested.

c. Results:

(1) Modified Pedestal Mount M63 (Figures 1, 2 and 3) (Trigger handles removed and adapter installed)

Part	Type Mount T12	Type Mount T13
Weight of feet (4) (lb.)	27.5	28.12
Weight of base (lb.)	82.0	97.5
Weight of pintle (lb.)	29.0	35.13
Weight of adapter for recoilless weapons (lb.)	4.25	4.25
Total weight (lb.)	142.75	165.00
Weight of 4.2" RCM complete with sight (lb.)	130.7	130.7
Total weight of gun and mount (lb.)	273.45	295.7
Graduations on traversing and elevating dials	Degrees	Mils
Free traverse	360	6400
Traverse using hand wheel	8.25	775
Free elevation	+49.8 to -16.4	+710 to -886
Elevation using hand wheel	6.4	510

(2) Lanyard Firing Devices for 4.2" Recoilless Mortar. (Figures 4, 5, 6, 7 and 8)

Item	Firing Device Type 3	Firing Device Type 4
Weight (lb.)	1.56	2.52
Maximum travel of lanyard parallel to axis of tube (in.)	3.5	4.5
Resultant travel of pin extractor (in.)	2.0	3.4
Required travel of pin to fire driver (in.)		
Split pin	2.0*	2.0
Solid pin	1.5	1.5

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Test No. 2 (SUPPLEMENTARY)

a. Purpose: To study mounting the recoilless weapons in the modified M63AA Mount.

b. Method:

(1) The handles and firing linkage were removed from each mount.

(2) An adapter designed to fit the M63 mount and to be held secure in the bracket for the .50 caliber machine gun was provided with mounting studs similar to those on the .30 caliber machine gun mount in order to receive all three recoilless weapons.

(3) The subject mounts were inspected with the 4.2" Recoilless Mortar mounted and defects noted.

c. Results:

(1) The T12 mount was inspected with the 4.2" Recoilless Mortar mounted and was eliminated from further test due to excessive lateral spring in the cradle of the mount, as well as the difficulty of manipulating the elevating hand wheel.

(2) The T13 mount was broken at the time of the initial inspection and no definite cause for breakage could be found. The pivot pin between the elevating arc and cradle was twisted off and the mount was unserviceable until repairs could be made. Further inspection disclosed that the mount was poorly constructed and that most of the attachments were loose or unstable. The mount was repaired by Ordnance.

(3) It was possible to mount the 4.2" Recoilless Mortar on the M63 mount type T32 by using the adapter constructed for that purpose. Both the elevating and traversing hand wheels are on the right side of the weapon while sights are on the left side.

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Test No. 3 (SUPPLEMENTARY)

a. Purpose:

(1) To determine the feasibility of using the Modified M63 Mount T13 for moving target firing with the 4.2" Recoilless Mortar.

(2) To determine the lead factor when firing the 4.2" Recoilless Mortar.

b. Method:

(1) Twenty rounds of ammunition were fired at moving targets towed laterally across the front of the weapon at constant speeds of 10 and 15 MPH at a range of 700 yards. The T13 type M63 Mount was used in this firing.

(2) Five rounds of ammunition were fired at each target speed, using the T13 sight and the iron sight mounted on the M4 sight.

(3) An initial lead of 11 mils was estimated and two rounds fired at a target moving 10 MPH laterally at a range of 700 yards. Both of these rounds struck behind the target. The lead for this target was increased to 14 mils and to 21 mils for a target speed of 15 MPH.

(4) The theoretical lead necessary to strike the target was calculated using an average muzzle velocity of 710 ft/sec.

(5) The strike of the rounds fired were noted for range and lead and the approximate relationship to the target.

c. Results of firing at moving targets:

Sight	Target Speed	Lead Used	Strike	
			Range	Lead
T13	10 MPH	14	over	10 mils behind
		14	correct	15 mils ahead
		14	lost	*
		14	short	5 mils ahead
M4 w/Iron Sight		14	short	15 mils behind

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Sight	Target Speed	Lead Used	Strike Range	Strike Lead
M4 w/Iron Sight (cont.)		14	correct	5 mils ahead
		14	short	10 mils behind
		14	correct	25 mils ahead
		14	over	15 mils behind
T13	15 MPH	21	short	20 mils ahead
		21	lost	*
		21	short	15 mils behind
		21	over	10 mils behind
		21	correct	5 mils ahead
M4 w/Iron Sight		21	over	10 mils ahead
		21	correct	25 mils behind
		21	over	5 mils behind
		21	short	15 mils ahead
		21	over	10 mils behind

*Gunner failed to observe sight azimuth had jumped 100 mils.

(2) Obvious in the above table is the inability of the gunner to control lead to a great extent. The firing of this test was conducted using the Type 4 lanyard firing device. Since the gunner must control the elevation and fire at the same time, the lead must be controlled by the hand which fires the piece. The job of the gunner, to continue to traverse as well as apply a continuous pull to the firing device, is very difficult, and probably would be inaccurate without the inherent delay during which the shell is propelled to the rear of the weapon. (Figure 12)

(3) On two occasions rounds struck the ground approximately 60 yards in front of the firing point. These rounds were not counted and were attributed to the gunner failing to zero the telescope of the T13 sight for elevation. This telescope has no positive lock in this position.

(4) Further testing of this mount with the recoilless weapons was discontinued at this point due to the serious vibration of the mount as well as the loosening of all parts due to the firing tests conducted.

(5) Prior to this test the subject mount was broken due to the separation and distortion of the elevation arc where it fastens to the cradle. This failure was repaired by ordnance personnel.

(6) The gunners right arm was swollen due to the severe whip in the weapon and mount striking the forearm while attempting to traverse. (Figure 12)

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(7) The traversing handwheel was not readily accessible to the gunner in the firing position due to its location on the right front side of the pedestal. (Figure 3)

(8) The calculated lead for the 4.2" Recoilless Mortar is as follows:

$$\text{LEAD (mils/mile/hour)} = \frac{\text{Target speed (mph)} \times 1000}{\text{Projectile speed (mph)}}$$

$$= \frac{10 \times 1000}{\frac{700 \times 3600}{5280}}$$

$$= 2.1 \text{ mils per mile per hour}$$

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Modified T13 Mount, used for moving target firing.

Note right hand under cradle operating elevating hand wheel. The traverse is free, since the left hand must be used to traverse and fire by using the handle of the lanyard firing device. The traversing hand wheel cannot be reached in this position.

Figure 12

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Test No. 4 (SUPPLEMENTARY)

a. Purpose: To determine the procedure required to load the 4.2" recoilless mortar when using the Type 3 and Type 4 lanyard firing devices.

b. Method: By observation of loading procedure during tests conducted.

c. Results:

(1) The Type 3 lanyard firing device consists of a simple linkage to change the direction of the applied force. In order to use this device the loader must hold the shell in the bore securely and carefully engage the claws of the device in the firing pin. Depending on the type of pin in the rocket driver, the loader must either place the claws of the device over the pin (cotter pin) or one of the claws through the pin ring (solid type). Some shifting of the projectile was required for this operation and the gunner must be forward of the muzzle. (Figures 4 and 5.)

(2) The Type 4 lanyard firing device consists of a straight line linkage to change the direction of pull of the applied force. In order to use this device the loader places the shell in the muzzle, places the device against the driver, where it is held by a spring, and slides the shell to the rear until the pin is engaged in the slot of the device. The loader does not have to change his position from alongside the tube after placing the shell in the weapon. (Figures 6, 7 and 8)

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Test No. 5 (SUPPLEMENTARY)

a. Purpose: To determine the speed of loading when firing at a fixed target, using the subject lanyard firing device.

b. Method:

(1) A fixed target at 100 yards was used for direct fire using the 4.2" Recoilless Mortar mounted on the machine gun tripod.

(2) One five-round series was fired with both split and solid types of driver pins, using hand firing and the Type 3 and 4 lanyard firing devices.

(3) The lay for elevation was corrected for each round. No correction for deflection was made. Inert ammunition was used in this test.

(4) Time was started as the first round fired and recorded as each successive round was fired.

c. Results:

Type of Firing Device	Round	Split Pin Time (sec.)	Split Pin Remarks	Solid Pin Time (sec.)	Solid Pin Remarks
Hand pulled	1	0		0	
	2	7		6	
	3	12		12	
	4	19		19	
	5	26		25	Driver burst
Type 3	1	0		0	
	2	19		23	
	3	31		38	
	4	41		50	
	5	62	Driver burst	74	
Type 4	1	0		0	
	2	12		9	
	3	21		16	
	4	31		24	
	5	60	Lanyard firing device did not pull pin first time (pin bent)	33	

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Note: No moving target firing was conducted against time due to the insecurity of the M63 mount and the types of sight under test.

Test No. 6 (SUPPLEMENTARY)

a. Purpose:

(1) To determine the comparative disturbance of the tube when pulling the driver pin by hand or when using the subject lanyard firing devices.

(2) To determine the practicability of using the subject lanyard firing devices for firing at moving targets.

b. Method: By observation of firing tests conducted.

c. Results:

(1) A sharp, fast withdrawal of the driver pin by hand appears to be the most accurate means of firing the subject weapon at a fixed target. The slow withdrawal of the pin when using the lanyard firing devices develops an unbalanced load that increases when the pin is withdrawn due to the wedging of the pin in the driver and due to the change of length of lever arms during the action of pulling the pin. This is also true when a sharp withdrawal is attempted when using the lanyard firing device.

(2) The use of the lanyard firing device is essential when firing at moving targets, however the necessity of firing from a free traverse permits a great error due to the weapon's inherent whip when fired. No difference could be noted in the firing using the two types of lanyard firing devices once the split pins had been cut off to allow easy extraction by the Type 3 device. (Test No. 1, c(2)).

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Test No. 7 (SUPPLEMENTARY)

a. Purpose: To determine if the Type 3 and 4 lanyard firing devices will hold the round in position when the angle of elevation is above that where the shell will slide into the tube without outside assistance.

b. Method:

(1) Two rounds were fired using each firing device at the following elevations: 190 mils, 210 mils, 220 mils and 600 mils.

(2) Observations were made and results noted.

c. Results:

(1) Rounds placed in the mortar tube did not slip when the tube was elevated to 190 and 210 mils.

(2) At 220 mils elevation the rounds slipped in the tube. Both rounds fired normally when using Type 4 device at this elevation.

The Type 3 device worked only when tension was maintained on the lanyard firing device. Release of the lanyard firing device allowed the driver pin to detach itself from the lanyard firing device and the shell to slide into the tube. The shell did not fire.

(3) The Type 3 device could not be used at 600 mils. The Type 4 device operated normally at 600 mils.

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Test No. 8 (SUPPLEMENTARY)

a. Purpose: To determine the force necessary to withdraw the driver pin when using a steady pull with the hand and with the Type 3 and 4 lanyard firing devices.

b. Method:

(1) Each of the above methods of pulling the driver pin was measured three times for each type of pin and the average determined.

(2) Inert drivers and new pins were used for each trial.

(3) The maximum amount of pull necessary to withdraw the pin was measured with a spring scale and recorded.

c. Results:

(1)

Type of Pull	Average Maximum Pull (lbs.) Split Pin	Solid Pin
Hand	15.3	19.8
Type 3	7.8	10.3
Type 4	13.6	18.1

(2) The Type 3 lanyard firing device has an increase of the necessary pull as the pin is withdrawn due to the decrease of the mechanical advantage. The Type 4 device has an almost constant pull during this operation.

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Test No. 9 (SUPPLEMENTARY)

a. Purpose: To compare the ease of mounting the T13 and M4 sights on the 4.2" and 75mm recoilless weapons.

b. Method:

(1) By inspection of the sights and mount and determining the necessary modifications to enable the use of the sights.

c. Results:

(1) The sight mount brackets on the 4.2" and 75mm recoilless weapons are identical in construction and position to those on the 60mm and 81mm mortars.

(2) The T13 sight is constructed for firing at flat angles of fire and may be used for high angle fire up to approximately 45°. The M4 sight is a high angle fire sight and when used in the standard sight mount is usable at angles of 40° to 90° only. In order to use the M4 sight for direct fire, an adapter was constructed which rotated the sight 45°, thus permitting the 45° sight setting to be level when the tube of the weapon is horizontal. The actual mounting block as made locally set the zero elevation at 46¼° on the M4 sight. The M4 sight could be used at angles of about -5 to +45° with the adapter and 40° to 90° without.

(3) Since firing tables are set up in mils for the 4.2" and 75mm recoilless weapons, the range information was converted to degrees by using a factor of 17.8 mils per degree. Sight settings were made on both the 4.2" and 75mm weapons by adding the converted range in degrees to 46-1/4° (the zero).

(4) There is no means of cross-leveling the sight on the 75mm Recoilless Rifle when using the M4 or the T13 sights. The 4.2" recoilless mortar sight mount has provision for cross-leveling the sight.

(5) The use of the panoramic mirror adapter with the 4.2" and 75mm recoilless weapons (Figure 10) appeared feasible since this sight adapter merely extends the use of the deflection offset from 300 to 6400 mils. The sight is still used in the same manner as before. It is necessary to raise the height of the sight on the 4.2" Recoilless Mortar in order to use the panoramic mirror adapter in all directions since the clamping handle on the

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sight mount bracket interferes with the line of sight in a limited sector to the right rear. This may be eliminated by use of the sight extension previously used with the 155mm mortar.

(6) The use of the iron sight with the 4.2" and 75mm recoilless weapons (Figure 11) is not feasible unless the subject device is a permanent attachment to the sight. In its present form the sight is not secure and cannot readily be returned to the same seating on the collimator head. During firing tests the sight was disturbed by each round fired and necessitated careful readjustment of the sight. The iron sight has a means of minor adjustments for deflection and elevation zeroing.

Test No. 10 (SUPPLEMENTARY)

a. Purpose: To compare the direct laying accuracy of the 4.2" Recoilless Mortar when fired using the T13 Sight and Iron Sight mounted on the M4 sight.

b. Method:

(1) Two 3-round shot groups were fired with the 4.2" Recoilless Mortar mounted on the machine gun tripod and using each of the subject sights.

(2) Both the T13 sight and the iron sight had to be carefully seated and checked before firing each round due to the whip of the gun disturbing the sight.

(3) Firing was conducted at two road junctions on an adjacent ridge and the shot groups plotted from data secured from two instruments situated on a measured base line.

(4) The Type 4 lanyard firing device was used in this firing.

c. Results:

(1) Shot groups Target 1

	Sight	
	T13	Iron on M4
Elevation	145 mils	8°
Range to target (yds.)	1410	1410
Range to center of impact (yds.)	1387	1362
Average range dispersion (yds.)	58	64
Average lateral dispersion (mils)	3.5	2

(2) Shot groups Target 2

Elevation	315 mils	18°
Range to target (yds.)	2452	2452
Range to center of impact (yds)	2431	2416
Average range dispersion (yds.)	38.8	46.5
Average lateral dispersion (mils)	4	1

(3) The area containing Target 1 was one which approached grazing fire, while that of Target 2 was plunging fire.

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Test No. 11 (SUPPLEMENTARY)

a. Purpose: To determine the suitability of the 4.2" Recoilless Mortar for indirect fire, when used in battery fire with other Infantry weapons and using data secured and distributed by a fire direction center using the M10 plotting board.

b. Method:

(1) Firing conducted for this test was in two locations. In each location the weapons were surveyed in by use of an aiming circle and a range finder at the OP. In the firing which employed the use of two 4.2" Recoilless Mortars both weapons could see and be seen by the OP.

(2) Methods used in paralleling weapons when using various sighting equipment.

(a) Artillery sight T13 and M4 sight with panoramic mirror

1. Level and zero aiming circle at O.P.

2. Read azimuth and SI to each gun using aiming circle.

3. Have each gun bore sight or lay on O.P. using sight and lock traverse.

4. Inform each weapon of azimuth from gun to O.P. and using this setting on the sight put in aiming stakes (north). Two stakes in same line were used to compensate for parallax caused by the offset of the sight from the center of rotation.

5. When stakes are in, move sight and weapon off of lay and with gun layed on O.P. again rotate sight to aiming stake to check accuracy.

(b) Dial on machine-gun tripod.

1. Read azimuth and SI to each gun using aiming circle.

2. Have each gun bore sight on O.P. and lock traversing mechanism.

3. Inform gun to set dial on machine-gun tripod to azimuth from gun to O.P. (use back azimuth of reading from aiming circle). Due to the split dial on the machine-gun tripod the azimuth reading must be indicated in red or black as figured.

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(c) Targets in the area were designated and fire data secured for each target as applied to each weapon involved. Data were secured from the O.P. using an aiming circle and range finder and computing the fire data for each weapon on the M10 Plotting Board.

(d) To study results the location of each target and shell burst was plotted from data secured from two aiming circles on a known base line. The error of firing was determined from the plotted data.

c. Results:

(1) Artillery sight T13 on 4.2" Recoilless Mortar.

	Gun No. 1	Gun No. 2
Range - C.P. to Gun (yds)	515	180
Azimuth - O.P. to Gun (magnetic)(mils)	844	2521
SI - O.P. to Gun (mils)	-44	-38
Sight setting with gun bore sighted on O. P. to put out North Stakes	844	2521

Target No. 1

Range - O.P. to Target (yds) 850		
Azimuth O.P. to Target (mils) 4796		
SI - O.P. to Target (mils) -11		
Range gun to Target (yds)	1275	980
Azimuth gun to Target (mils)	4511	4942
Sight setting (deflection mils)	1889	1458
Elevation for range (mils)	137	105
SI Gun to Target (mils)	0	-2
Elevation on sight (mils)	137	103
Error in deflection (mils)	12 left	1 left
Error in range (yds)	4 short	4 over
Necessary range correction (mils)	(within dispersion of weapon)	

Target No. 2

Range O.P. to target (yds) 790		
Azimuth O.P. to target (mils) 4874		
SI - O.P. to targets (mils) -19		
Range gun to target (yds)	1210	890
Azimuth gun to target (mils)	4548	5030

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	Gun No. 1	Gun No. 2
Sight setting (deflection mils)	1852	1370
Elevation for range (mils)	135	105
S I Gun to target (mils)	-7	-12
Elevation on sight (mils)	128	93
Error in deflection (mils)	8 left	2 right
Error in range (yds)	25 short	108 over
Necessary range correction (mils)	up 4	down 16

Target No. 3

Range O.P. to Target (yds)	550		
Azimuth O.P to Target (mils)	5298		
SI O.P. to Target (mils)	-19		
Range gun to Target (yds)		860	725
Azimuth Gun to Target (mils)		4680	5386
Sight setting (deflection mils)		1720	1014
Elevation for range (mils)		90	74
S I Gun to Target (mils)		-4	-7
Elevation on sight (mils)		90	67
Error in deflection (mils)		16 left	6 left
Error in range (yds)		120 short	50 short
Necessary range correction (mils)		up 12	up 2 *

Target No. 4

Range - O.P. to Target (yds)	1600		
Azimuth - O.P. to Target (mils)	4921		
S I - O.P. to Target	-8		
Range - Gun to Target (yds)		1970	1750
Azimuth - Gun to Target (mils)		4720	4992
Sight setting (deflection mils)		1630	1408
Elevation for range (mils)		250	200.5
S I Gun to Target (mils)		-3	-5
Elevation on Sight (mils)		247	195.5
Error in deflection (mils)		2 left	9 left
Error in range (yds)		120 short	9 short
Necessary range correction (mils)		up 8	None

Target No. 5

Range - O.P. to Target (yds)	1275		
Azimuth - O.P. to Target (mils)	4994		
S I - O.P. to Target (mils)	-14.5		
Range - Gun to Target (yds)		1640	1435

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	Gun No. 1	Gun No. 2
Azimuth - Gun to target (mils)	4725	6075
Sight setting (deflection mils)	1675	1325
Elevation for range (mils)	186	159
S I - Gun to target (mils)	-7	-9
Elevation on sight (mils)	179	150
Error in deflection (mils)	5 left	5 left
Error in range (yds)	36 short	28 short
Necessary range correction (mils)	up 3	up 2

Target No. 6

Range - O.P. to target (yds)	780
Azimuth - O.P. to target (mils)	4860
S I - O.P. to target (mils)	-17

Range - Gun to target (yds)	1210	900
Azimuth - Gun to target (mils)	4532	5005
Sight setting - deflection (mils)	1368	1395
Elevation for range (mils)	130	93
S I - Gun to target (mils)	-9	-13
Elevation on Sight (mils)	121	80
Error in deflection (mils)	32 left	27 left
Error in range (yds)	75 short	40 over
Necessary range correction (mils)	up 5	down 2

(2) Machine-gun dial and clinometer

	Gun No. 1	Gun No. 2
Range - O.P. to target (yds)	330	530
Azimuth - O.P. to gun (magnetic) (mils)	5375	5371
S I - O.P. to gun (mils)	-33	-24
Setting of machine-gun dial with weapon bore sighted on O.P.	2840(black)	2835(black)

Target No. 1

Range - O.P. to target (yds)	1760
Azimuth - O.P. to target (mils)	663
S I - O.P. to target (mils)	-7

Range gun to target (yds)	1625	1540
Azimuth Gun to target (mils)	841	965
Dial setting (deflection mils)	841(black)	965(black)

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		Gun No. 1	Gun No. 2
Elevation for range (mils)		183	172
S I Gun to target (mils)		-2	0
Elevation on clinometer (mils)		181	172
Error in deflection (mils)		1 left	11 left
Error in range (yds)		short 72	short 119
Necessary range correction (mils)		up 9	up 14

Target No. 2

Range - O.P. to target (mils)	1725		
Azimuth - O.P. to target (mils)	518		
S I - O.P. to target (mils)	-7		
Range - Gun to target (yds)		1550	1450
Azimuth - Gun to target (mils)		682	808
Dial setting (deflection mils)		682(black)	808(black)
Elevation for range (mils)		174	160
S I Gun to target (mils)		-2	0
Elevation on clinometer (mils)		172	160
Error in deflection (mils)		20 left	26 left
Error in range (yds)		157 over	123 over
Necessary range correction (mils)		down 17	down 16

Target No. 3

Range - O.P. to target (yds)	1700		
Azimuth - O.P. to target (mils)	643		
S I - O.P. to target (mils)	-7		
Range - Gun to target (yds)		1550	1500
Azimuth - Gun to target (yds)		829	954
Dial setting (deflection mils)		829(black)	954(black)
Elevation for range (mils)		173	167
S I - Gun to target (mils)		-1	0
Elevation on clinometer (mils)		172	167
Error in deflection (mils)		15 left	8 left
Error in range (mils)		446 over	5 short
Necessary range correction (mils)		down 14	None
		(estimated)*	

Target No. 4

Range O.P. to target (yds)	1700
Azimuth - O.P. to target (mils)	519
S I - O.P. to target (mils)	-5

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		Gun No. 1	Gun No. 2
Range - Gun to target (yds)		1520	1420
Azimuth - Gun to target (mils)		681	757
Dial setting (deflection mils)		681(black)	757(black)
Elevation for range (mils)		160	147
S I - Gun to target (mils)		41	43
Elevation on clinometer (mils)		161	150
Error in deflection (mils)		41 left	64 left
Error in range (yds)		12 short	352 over
Necessary range correction (mils)		None	up 23 *
Target No. 5			
Range - O.P. to target (yds)	1527		
Azimuth - O.P. to target (mils)	77		
S I - O.P. to target (mils)	-26		
Range - Gun to target		1175	1075
Azimuth - Gun to target		190	285
Dial setting (deflection mils)		190(black)	285(black)
Elevation for range (mils)		126	114
S I Gun to target (mils)		-24	-24
Elevation on clinometer (mils)		102	90
Error in deflection (mils)		7 left	14 left
Error in range (yds)		12 over	10 short
Necessary range correction (mils)		None	None
Target No. 6			
Range - O.P. to target (yds)	1640		
Azimuth - O.P. to target (mils)	740		
S I - O.P. to target (mils)	-17		
Range - Gun to target (yds)		1510	1470
Azimuth - Gun to target (mils)		943(black)	1069(black)
Elevation for range (mils)		158	163
S I Gun to target (mils)		-13	-12
Elevation on clinometer (mils)		145	151
Error in deflection (mils)		4 right	6 left
Error in range (yds)		85 over	46 over
Necessary range correction (mils)		down 11	down 5

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(3) Panoramic Mirror adapter on M4 Sight

		Gun No. 1
Range - O.P. to Gun (yds)		515
Azimuth - O.P. to Gun (magnetic)(mils)		844
S I - O.P. to Gun (mils)		-44
Sight setting with gun bore sighted on O.P. to put on North Stakes (mils)		4044
Target No. 1		
Range O.P. to target (yds)	725	
Azimuth - O.P. to target (mils)	4618	
S I - O.P. to target (mils)	-20	
Range - Gun to target (yds)		1175
Azimuth - Gun to target (mils)		4370
Sight setting (deflection mils)		4370
Elevation for range (mils)		126
S I - Gun to target (mils)		-7
Elevation for target (mils)		119
Elevation for M4 sight (degrees)		6.7
Error in deflection (mils)		15 right
Error in range (yds)		85 short
Necessary range correction (degrees)		up .5
Target No. 2		
Range O.P. to target (yds)	860	
Azimuth O.P. to target (mils)	4768	
S I - O.P. to target (mils)	-7	
Range - Gun to target (yds)		1300
Azimuth - Gun to target (mils)		4490
Sight setting (deflection mils)		4490
Elevation for range (mils)		141
S I - Gun to target (mils)		-1
Elevation for target (mils)		142
Elevation for M4 Sight (degrees)		8
Error in deflection (mils)		10 left
Error in range (yds)		67 over
Necessary range correction (degrees)		down .5

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		Gun No. 1
Target No. 3		
Range - O.P. to target (yds)	1275	
S I - O.P. to target (mils)	-10	
Range - Gun to target (yds)		1650
Azimuth - Gun to target (mils)		1678
Sight setting (deflection mils)		4678
Elevation for range (mils)		187
S I - Gun to target (mils)		-3
Elevation for target (mils)		184
Elevation for M4 Sight (degrees)		10.3
Error in deflection (mils)		25 left
Error in range (yds)		72 short
Necessary range correction (degrees)		up .75
Target No. 4		
Range - O.P. to target (yds)	1600	
Azimuth - O.P. to target (mils)	4918	
S I - O.P. to target (mils)	-8	
Range - Gun to target (yds)		2725
Azimuth - Gun to target (mils)		5028
Sight setting (deflection mils)		5028
Elevation for range (mils)		362
S I Gun to target (mils)		-11
Elevation for target (mils)		351
Elevation for M4 sight (degrees)		19.7
Error in deflection (mils)		32 left
Error in range (yds)		352 over
Necessary range correction (degrees)		down 2.75
Target No. 5		
Range O.P. to target (yds)	1600	
Azimuth O.P. to target (mils)	4918	
S I - O.P. to target (mils)	-8	
Range - Gun to target (yds)		1975
Azimuth - Gun to target (mils)		4710
Sight setting (deflection mils)		4710
Elevation for range (mils)		233

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		Gun No. 1
S I - Gun to target (mils)		-3
Elevation for target (mils)		230
Elevation for M4 sight (degrees)		13
Error in deflection (mils)		35 left
Error in range (yds)		197 over
Necessary range correction (degrees)	down	2 *

Target No. 6

Range - O.P. to target (yds)	2375	
Azimuth - O.P. to target (mils)	5289	
S I - O.P. to target (mils)	-12	
Range - Gun to target (yds)		2575
Azimuth - Gun to target (mils)		5090
Sight setting (deflection mils)		5090
Elevation for range (mils)		333
S I - Gun to target (mils)		-6
Elevation to target (mils)		327
Elevation for M4 Sight (degrees)		18.4
Error in deflection (mils)		20 left
Error in range (yds)		37 over
Necessary range correction (degrees)		None

*Projectile cleared hill and struck the next ridge as target was on reverse slope

(4) Average errors in range and deflection

Type Sight	Rounds Fired	Average of Rounds Indicated Deflection (mils)	Range (yds)
T13	12	11.4	51.8
Dial and clinometer	12	18.1	112.0
Mirror adapter on M4 Sight	6	23.0	135.0

(5) The 4.2" Recoilless Mortars used in this firing were out of balance and did not remain in the same position from round to round. An attempt was made to place the weapons in position before each round was fired.

(6) The errors indicated in the above test are accumulations of irregularities in the weapon as well as those errors made in the securing and calculating of fire data.

Test No. 12 (SUPPLEMENTARY)

a. Purpose: To note irregularities in the performance of the driver rocket during firing tests.

b. Method: By observation of firing conducted.

c. Results:

(1) Three rocket Drivers E-21-32 packed with HE ammunition Lot MFH-1 failed out of 51 rounds fired.

(a) Two rockets failed to ignite when the lanyard was pulled. When struck from the shell by the gunner's hand the driver fired upon impact with the body of the vehicle from which it was being fired.

(b) One rocket failed due to rupture of the motor tube. In this case the driver was split axially the complete length of the motor tube and the venturi head was gone. The driver was detached from the shell and the shell driven approximately 6" into the mortar tube.

(2) One driver from an ammunition lot for "proofing and testing" split as in 1a. There was no lot number information on either the round or the driver concerned.

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5. Summary of Facts.

a. The T-12 type of M-63 AA mount weighs less than the T-13 type mount. (Test No. 1)

The T-13 type mount has the traversing and elevating dials graduated in degrees while those of the T-13 mount are graduated in mils. (Test No. 1)

The Type 4 lanyard firing device weighs approximately one pound more than the Type 3. (Test No. 1)

The linear travel of the pin extractor of the Type 4 lanyard firing device is 3.4 inches while that of the type 3 is 2 inches. (Test No. 1)

The T-13 telescope sight weighs 5.18 pounds while the M-4 sight weighs 1.21 pounds. With the Iron sight attached, the M-4 sight weighs 1.5 pounds and with the mirror adapter, 1.61 pounds. (Test No. 1)

b. The T-12 type mount was not considered suitable due to excessive lateral spring in the cradle of the mount as well as the difficulty of manipulating the elevating hand wheel. (Test No. 2)

The T-13 mount was broken prior to the initial inspection and had to be repaired. Inspection disclosed that the mount was poorly constructed. (Test No. 2)

c. The gunner cannot control the lead of the 4.2" Recoilless Mortar when using a free traverse, due to the time lapse between the firing of the driver and the return of the shell. (Test No. 3)

A lead of 1.4 mils per mile per hour for targets crossing the front at a range of 700 yards appears to be the correct lead factor when firing the 4.2" Recoilless Mortar. (Test No. 3)

d. The Type 3 lanyard firing device requires the loader to be forward of the gun muzzle in order to engage the driver firing pin while the loader may remain in his normal loading position along side the tube when using the Type 4 lanyard firing device. (Test No. 4)

e. The hand firing of the 4.2" Recoilless Mortar is the fastest method, however, the Type 4 lanyard firing device was nearly as fast while the Type 3 lanyard firing device required much more time. (Test No. 5)

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f. When firing at a fixed target, a sharp withdrawal of the firing pin is apparently the most accurate. The use of a lanyard firing device is essential when firing at a moving target. (Test No. 6)

g. The Type 4 lanyard firing device will hold the shell in place at angles above which the shell will slide into the tube. This is not true of the Type 3 device (Test No. 7)

h. The Type 3 lanyard firing device does not require as much pull to extract the driver firing pin as does the Type 4 device. (Test No. 8)

i. The angle of inclination of the sight mount on the 4.2" and 75mm recoilless weapons is the same as that of the 60mm and 81mm mortars with reference to the axis of the tube. (Test No. 9)

The M-4 sight must have a modified sight bracket in order to fire at angles below 40'. (Test No. 9)

There is no means of cross leveling the sight on the 75mm recoilless rifle. (Test No. 9)

The combination of the M-4 sight and panoramic mirror adapter appear feasible for use on the 4.2" and 75mm recoilless weapons since the mirror does not have to become a fixed part of the sight. (Test No. 9)

The sight extension should be a part of the equipment of the 4.2" Recoilless Mortar should the sight be adapted to this weapon. (Test No. 9)

The Iron sight must be a permanent part of M-4 sight in order to be suitable for firing with the recoilless weapons. (Test No. 9)

j. There appears to be little difference in the accuracy of the 4.2" Recoilless Mortar when using the T-13 and the Iron sight for direct firing. (Test No. 10)

k. The following are the average errors in range and dispersion per round fired. This firing was conducted using each of the indicated sights for indirect fire in conjunction with a fire direction center which secured all range data and distributed fire data through the use of a range finder, aiming circle and M10 plotting board. (Test No. 11)

Type Sight	Rounds fired	Average error per round	
		Deflection (mils)	Range (yards)
T13	12	11.4	51.8
Dial and Clinometer	12	18.1	112.0
Mirror adapter and M4 Sight	6	23.0	135.0

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1. The driver rockets on the shells for the 4.2 inch Recoilless Mortar are not dependable and are a mental as well as a physical hazard to the gun crew when failure occurs. (Test No. 12)

WILLIAM S. SINCLAIR, JR.,
Major, Infantry,
Test Officer.

I concur in the above record of test:

EDWARD B. CROSSMAN,
Lt. Col., Infantry,
Test Section Executive.